The Oxford Dictionary of Natural History

Edited by Michael Allaby

Foreword by David Attenborough

Popular interest in natural history is widespread and constant, outliving transient fashions that attract people to other subjects, as each generation discovers that some knowledge and understanding of the natural world enhances our enjoyment of the countryside. In recent years other scientific disciplines, some of them relatively new, have added greatly to our knowledge, but in doing so they have introduced concepts and terms that may be unfamiliar to non-specialists. This dictionary lists many groups of plants and animals, but it also includes terms from ecology, statistics, earth sciences, atmospheric sciences, and biochemistry that may be encountered in literature dealing with aspects of plant or animal growth, structure, or behaviour. At the same time, it will be of use to those concerned with other disciplines who are unfamiliar with taxonomic terms that may occur in literature of special interest to them. The dictionary contains over 12 000 entries, written by a team of more than 25 specialists aided by consultants, and its coverage is world-wide. It will be of value to students as well as to those who derive pleasure from the wildlife around them, or even from well-tended gardens, and who wish to support personal observations by reading and watching films, but need ready access to authoritative explanations of unfamiliar expressions.

Michael Allaby is an experienced writer and broadcaster on the environment. From 1970 to 1973 he was Managing Editor of the *Ecologist* and contributed to the *Blueprint for Survival*. Since 1973 he has been a full-time writer. Amongst his publications are *A Dictionary of the Environment* (general editor), *Inventing Tomorrow*, *A Year in the Life of a Field*, *The Politics of Self-Sufficiency* (with Peter Bunyard), and *The Great Extinction* (with J. E. Lovelock).

Jacket illustration: honey possum on coral gum. Photograph: Sean Morris/Oxford Scientific Films.

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FOREWORD

THE first time I travelled in the forests of Borneo, I knew no Malay. My guide, a Dyak hunter who, with his blowpipe, regularly collected birds for the local museum, knew no English. So, to begin with, we had some difficulty—to put it mildly—in sorting out where we should go and what we should do. On our first day out together, we were paddling up a river in a canoe, when I heard a sonorous *tok-tok-tok-tok* call echoing through the trees. It was a sound that later I came to know well, but at that time I had no idea what creature made it. I cupped my hand round my ear and raised my eyebrows towards my guide. He then, for the very first time in our acquaintance, spoke words that I precisely understood. '*Caprimulgus macrurus*', he said and I knew immediately that I was listening to the voice of the long-tailed nightjar. It was a nice demonstration that those cumbersome Latin names, sometimes mocked by the ignorant as pretentious obfuscations invented by scientists to prevent others understanding what they are talking about, do indeed constitute a truly international lingua franca.

Such scientific terms, of course, are valuable not only because they transcend linguistic barriers but because they are exceedingly precise. *Caprimulgus macrurus* can be expanded, with the right reference book to hand, into an exact description of a particular bird with its own characteristic colour, shape, distribution, diet—and call. Nor are such words needed only for the classification of organisms. Processes and periods, concepts and characters, anatomies and activities all have to be given names if they are to be discussed and referred to in a way that is both precise and succinct. So there is no escaping from it: scientific language has to be tackled and mastered if scientific thought is to be followed.

That language, of course, may present problems to full-time scientists themselves on occasion. Even working within their own particular disciplines, they may occasionally be baffled, for new terms are continually being coined to enable workers to investigate and discuss new discoveries and perceptions. It is commonly said that these days science is becoming so highly specialized that individual workers tend to know more and more about less and less. That may be so in some areas, but in natural history the trend is in the other direction. These days, we are recognizing with increasing clarity that plants and birds, insects and flowers, soil and rainfall, all form one intricately connected web. It is significant that the very term needed to describe this unity—ecosystem—was coined only 50 years ago and very properly appears in this dictionary. But this widening of scope increases the problems of vocabulary. An amateur naturalist may know that *Caprimulgus* is a nightjar, but it is less likely that a professional botanist will. Once, that might not have mattered very much. Now, in these ecologically conscious times, it may well be of some consequence for him to do so.

But if the situation is becoming troublesome for the professional how much more difficult it now is for the amateur. Not so long ago the very word 'naturalist'

was applied only to amateurs and used in a somewhat condescending not to say dismissive way. It suggested someone who patiently amassed meaningless and trivial facts about butterflies, birds' eggs, and wild flowers. But once, of course, everyone had to be a naturalist. Hunters, like my Dyak guide, had to have expert knowledge of the natural world if they were to catch their quarry. Housewives had to be able to recognize plants and know which was edible and which poisonous. Those skills are no longer required of most of us. We live in cities and even those who provide us with our foods and medicines no longer gather them from the wild. But many of us, nonetheless, still depend upon the wild, finding it a matchless source of wonder, fascination, and solace. Our delight in it, however, is greatly heightened if we are able to share in the discoveries and debates of scientists who spend their whole lives investigating it. And since natural history does indeed rest ultimately on the recording of a mass of tiny observations, we can even make our own small contributions. So happily, today, the name 'naturalist' is one of which anyone can be proud. But being a competent one now requires, once again, an understanding of the language.

Some of us, perhaps, with just the vaguest recollection of our schoolboy Latin or Greek may be able to deduce meanings of a proportion of such words without recourse to a glossary. That ability, for me, has been the only abiding benefit of those numberless, mind-numbing hours spent chanting in unison the conjugations and declinations of classical verbs and nouns. Today, such subjects are no longer taught in schools as a matter of course, and I, for one, do not greatly regret the change. But even with those hazy memories, deducing the meaning of scientific terms is not easy. They might have led me to guess that *Caprimulgus* meant 'goat-sucker' and from that I might have remembered that in ancient times that name was given to the nightjar in the mistaken belief that it stole milk from goats. But the deduction would have been a circuitous one and arguably might demand a greater knowledge of natural history than would have been needed to recognize the name in the first place.

But with this book to hand, you no longer have any need to attempt such etymological puzzles. Here, for each of many thousands of scientific terms, are those few words of definition that will enable you, whether scientist, naturalist, or both, to understand the word and the sentence in which it is embedded. The entries have been assembled and defined by over fifty experts from a dozen different disciplines. I know of no other compilation that is so up-to-date and so comprehensive. Maybe, in some laboratory or library somewhere, there sits some scientific polymath who, alone and unaided, knows the meaning of each and every one of these words. I am not he. I am delighted—and relieved—to have at last a volume at my elbow that will illuminate my way through the fascinating literature of natural history, no matter where it may lead me.

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PREFACE

OUR century has seen an expansion of scientific research without parallel in history, and the rate of expansion shows no sign of abating. Schoolchildren today receive instruction in disciplines that did not even exist when the older among us were at school, and new information technologies have been pressed into the service of storing and disseminating information, which accumulates faster than it, far less all of its implications, can be absorbed by a merely human brain.

This creates a linguistic problem. Workers within each discipline coin technical words and expressions to describe their findings and ideas, and with each new discovery and each new theory specialist vocabularies grow. While scientists remained confined within the bounds of particular disciplines, this was a problem for them alone, and manageable; but disciplinary boundaries are drawn less precisely today than once they were. All of us, professional or amateur students of the natural world, must master vocabularies, and the concepts underlying them, derived from several disciplines if we are to understand fully the literature pertaining to any one of those disciplines.

This is especially true in the area of study loosely called 'natural history', and it is important. Almost the whole of science has become the preserve of the professional, but in observational astronomy and in the observation of plants and animals—and possibly nowhere else—the amateur may still contribute to the store of useful information. Networks of observers and recorders play a vital role in the mapping of the distributions of species, and many rare species and valuable habitats can be maintained within nature reserves only because local naturalists are willing to devote time and physical effort to the management of the reserves. Without such dedicated amateurs these tasks would be far too costly to be performed at all, and we would be the poorer. Yet the amateur who wishes to read and so advance from a general to a more specialized knowledge of the subject must acquire some familiarity with expressions used in a formidable range of disciplines that must at first seem peripheral. The student, at school or in higher education, must become even more familiar with those disciplines.

There is a need, then, for an aid to communication, and it is this need that the present *Dictionary* aims to meet. It is intended for students, for amateur naturalists, and indeed for all those who would pursue their interest in natural history beyond the level of the more popular books, articles, and television programmes.

The area is vast, and space within a single book is limited. In compiling the *Dictionary*, therefore, it was necessary to make entirely arbitrary decisions. We began by deciding the overall size of the book and the total number of entries it might contain. I listed the disciplines that seemed relevant (and added a few more at a later stage), allotted a priority to each, then converted those priorities into numbers of entries for each discipline. Thus space was allocated to the earth sciences (geology, geomorphology, pedology, and mineralogy), the

atmospheric sciences, genetics, cell structure and function, biochemistry, parasitology, and other disciplines. The *Dictionary* cannot claim to be fully comprehensive, but if there are major omissions the blame must rest with me.

Since the broad subject is natural history, clearly the *Dictionary* had to list many taxa of plants and animals. My aim in selecting such entries was to provide as complete a listing as was practicable down to the family level, and to include any lower taxa of particular interest. Coverage in all disciplines aimed to be global. The decisions were mine, but they were more flexible than it may seem since the division of the overall subject served merely as a rough guide to contributors, some of whom departed from it, usually by exceeding the number of entries allocated to them.

Abbreviations have been kept to a minimum, and I hope they are self-explanatory: 'geol.' stands for 'geology', 'geomorph.' for 'geomorphology', 'bot.' for 'botany', etc. 'Compare' has been used rather than 'cf.', and 'q.v.' has not been used at all because it would interrupt the flow of entries, making them more difficult to understand, while contributing little of value. In most cases technical terms used within entries are defined within the entry, or by themselves, or within another entry to which the reader is directed.

Plants and animals have been described under their scientific names, with their common names in parenthesis and in cross references to the main entry. In most cases the entry describes organisms at one of the higher taxonomic levels and for this reason the common name may appear in the plural. Members of the family Meleagrididae, for example, are turkeys, but there are two distinct species so the use of the plural is more accurate. For consistency the plural is also used in the cross reference. If a common name does not appear in its correct alphabetical position in the singular form, therefore, it may be because it appears in the plural.

I pretend no great expertise in any scientific discipline. My contribution consisted mainly in administering the project, editing the entries I received, and assembling them in the form of computer files. In that task I received invaluable assistance from my wife, Ailsa, who devised an efficient filing system, as well as typing many of the early entries, helping to check them, and contributing some herself. Although I wrote a number of the entries, most were written by our team of contributors, recruited from the relevant disciplines, and reviewed by independent consultants, as well as by my colleagues at the Oxford University Press.

I am deeply grateful to Neil Curtis, who first suggested that I might compile this book, and to Nicholas Wilson and Christopher Riches of the Oxford University Press whose friendship, support, and practical help have been invaluable, and whose patience as deadlines came, went, and vanished into the remote past has been remarkable. I thank all the contributors for undertaking the task so cheerfully and for pursuing it so conscientiously. I congratulate those among them who became parents during the years it has taken to compile the *Dictionary*.

I must also express my sorrow at the death of Donald Street, the herpetologist, who was among the very first to agree to contribute to the book. He is missed.

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aa *See* lava.

Aapa mires String bogs of circumpolar distribution, particularly in Fenno-Scandia. They are soligenous mires (i.e. they receive water from rain and slope run-off), with ridges, which are morainic in origin, arranged roughly normal to the slope of the terrain. Water occupies the linear depressions between the ridges.

aardvark (ant bear, *Orycteropus afer*) *See* Orycteropodidae.

aardwolf (*Proteles cristatus*) *See* Hyaenidae.

abacá (Manila hemp) The strongest of the hard, natural fibres. It is extracted from the pseudostems of *Musa textilis*, a relative of the edible bananas. Grown mainly in the Philippines, and native to that region, it is used to make ropes that are resistant to humidity and to salt water and fresh water, and to make specialist strong papers (e.g. for tea bags).

abdomen 1 In vertebrates, the region of the body that contains the internal organs other than the heart and lungs. In Mammalia it is bounded anteriorly by the diaphragm. 2 In most arthropods, the hind region (tagma) of the body, which contains most of the digestive tract, the gonads, and the genital openings. In Crustacea, the abdomen bears limbs which are to a greater or lesser extent segmentally arranged and the abdomen is not homologous with that of arachnids and insects. The abdomen usually shows at least some trace of segmentation, though in the course of evolution this has been lost in all but one family of spiders. 3 In insects, the segments of the body that lie posterior to the thorax. The abdominal segments carry no limbs, although there are appendages (associated with reproduction) on the terminal segments. In the primitive state the abdomen consists of eleven segments, but this number may be very much reduced in advanced insects.

abdominal fins In fish, pelvic fins located far back on the belly of a fish, rather than in the thoracic or jugular position. The term may also be applied to ventral fins found on the abdominal (or belly) side of the body of a fish.

Abies (fir; family Pinaceae) Genus of coniferous trees. The leaves are crowded on the twigs, often approximately in two rows; they are needle-like and single, leaving a round, flat scar when they fall, so giving a smooth twig. The female cones are borne erect: they shatter at maturity, but the woody axis persists. Many fine ornamental species are now widely cultivated for their lofty, deeply pyramidal, monopodial crown; but they require a moist climate and are sensitive to atmospheric pollution. There are 40–50 species, widespread throughout the northern hemisphere, especially on mountains.

abiogenesis Development of living organisms from non-living matter, as in the supposed origin of life on Earth, or in the concept of spontaneous generation which was once held to account for the origin of life but which modern understanding of evolutionary processes has rendered outdated.

abiotic Non-living; devoid of life. *See* biotic.

ablation 1 Removal of snow and ice by melting and direct alteration from the solid to gaseous phase (sublimation). The rate of loss is controlled chiefly by air temperature, wind velocity, humidity, rainfall, and solar radiation. Ablation on snowfields is also influenced by aspect, depth of snow, and nature of the underlying surface. Ablation till (flow till) is the glacial debris that may be released. The ablation zone of a glacier is that area in which losses, including calving, exceed additions. 2 Removal of rock material, especially by wind action.

ablation till (flow till) *See* ablation; and till.

ablation zone *See* ablation.

abomasum In Ruminantia, the fourth and final region of the specialized stomach. It is the zone of digestion.

aboral Away from the mouth; on the opposite side of the body from the mouth.

abrasion The erosive action that occurs when rock particles of varying size are dragged over or hurled against a surface. Some common agents of abrasion are the bedloads of streams, rock debris embedded in the bases of glaciers, and sand and shingle carried by wind or waves.

Abrocomidae (rat chinchillas; order Rodentia, suborder Hystricomorpha) Family of medium-sized, rat-like rodents, with stiff hairs projecting over the nails of the three central digits of the hind feet. The skull is massive and narrow in the facial region; the braincase is rounded, with low occipital crests and short paroccipital processes; and the cheek teeth are hypsodont. Rat chinchillas live in colonies in burrows or crevices, and can climb trees. They are found only in the Andes from S. Peru to N. Argentina. There are two species in a single genus, *Abrocoma*.

abscisic acid A terpenoid compound that is one of the five major plant hormones. Although it is synthesized principally in the chloroplasts it occurs throughout the plant body and is particularly concentrated in the leaves, fruits, and seeds. It has powerful growth-inhibiting properties generally and also promotes leaf abscission and the senescence of plants and/or their organs, and induces the closing of stomata and dormancy in seeds and buds.

In its effects it is antagonistic to the plant growth hormones, and is thought to act by inhibiting the synthesis of protein and nucleic acids.

abscission Rejection of plant organs, e.g. of leaves in autumn. This occurs at an abscission zone, where hydrolytic enzymes reduce cell adhesion. The process can be inhibited by respiratory poisons, and is controlled in nature by the proportion and gradients of auxin and ethene. Other hormones may be involved.

absent rings *See* tree ring.

absolute humidity *See* humidity.

absolute pollen frequency (APF) The expression of pollen data from sediments in terms of the absolute numbers—for each species, genus or family—per unit volume of sediment and, where deposition rates are known, per unit time. In certain circumstances this approach gives clearer information than does the traditional expression as relative pollen frequencies (RPF). APFs are particularly useful in site comparisons in which one or more high-pollen producers vary. For example, when trees first appear in the regional pollen rain their prolific pollen may, in an RPF method, give the impression of declining herbaceous species, whereas examination by an APF method will show constant values for herb species.

absorption Uptake of substances, usually nutrients, water, or light, by cells or tissues.

Abutilon (family Malvaceae, tribe Abutileae) Genus of trees and shrubs, native to all arid zones of the world. It includes Chinese lanterns, grown as ornamentals. They have hairy leaves and branches, and bright, lantern-like flowers, mainly orange or red. The fruit is a schizocarp and the stigmas are usually apical. There are 30 species, all in N. Australia. The genus includes *A. avicenae* (China jute).

Abutilon avicenae (China jute) *See Abutilon*.

abyssal fish Fish living in the abyssal zone of the ocean. Many abyssal species have a prominent snout; a tapering, rat-tailed body, consisting of flabby, watery tissue; and a lightweight skeleton.

abyssal hills Relatively small topographical features of a dominantly flat deep-ocean floor, commonly 50–250 m in height and a few kilometres in width. They are most typical of the Pacific Ocean floor at depths of 3000–6000 m.

abyssal plain Smooth, almost level area of the deep-ocean floor in which the gradient is likely to be as low as 1 : 10 000. The covering sediments are usually thin deposits of a pelagic ooze or distal turbidite.

abyssal zone Zone of greatest ocean depth—that is, below a depth of 2000 m. This zone lies seaward of, and deeper than, the bathyal zone, and covers approximately 75% of the total ocean floor. It is the most extensive Earth environment, cold, dark, and still, supporting fauna that typically are black or grey, delicately structured, and not streamlined.

Abyssinian roller (*Coracias abyssinica*) *See Coracias*.

Acacia (family Leguminosae, subfamily Mimosoideae) Genus of plants, most of which are trees (wattles), although some are climbers. Typically the leaves are bipinnate, with numerous tiny leaflets, or phyllodic. They are important for timber, fuelwood, tannin, gum arabic (especially *A. senegal*), perfumes (*A. farnesiana*), and florists' 'mimosa' (usually *A. dealbata*). There are 750–800 species, most of them seasonal in the tropics and subtropics.

Acaena (family Rosaceae, subfamily Rosoideae, tribe Sanguisorbeae) Genus of wind-pollinated, mat-forming plants occurring mainly in the subtropics and temperate regions. There are rather more than 100 species; 90 species are found in S. America, 14 in New Zealand, two in Australia, and others in New Guinea, S. Africa, and California.

Acalypha (family Euphorbiaceae) Genus of shrubs and small trees. The flowers are unisexual and apetalous, males having elongate, twisted anther-lobes, and females much-branched stigmas; some species bear catkins, as in the ornamental *A. hispida* ('cat's tail'). *A. wilkesiana* and others have colourful foliage. There are no close relatives in the family; the resemblance to Urticaceae is only superficial. There are about 450 species, found in the tropics and subtropics.

Acanthaceae Family mainly of shrubs, in which the leaves are simple, opposite, and decussate. The flowers are bisexual and zygomorphic, and the bracts are often showy. There are four or five fused sepals and petals; 2–4 epipetalous stamens; a superior, bilocular ovary; and numerous, axile ovules. The fruit is a capsule. There are several ornamentals, e.g. *Acanthus*, *Aphelandra*, *Thunbergia*. There are about 250 genera, comprising about 2000 species, most of them tropical, but with temperate outliers.

Acanthisittidae (New Zealand wrens) *See* Xenicidae.

acanthite *See* argentite.

Acanthiza (thornbills; family Acanthizidae) Genus of warblers, sometimes placed in the Sylviidae or Maluridae. They are small, active, insectivorous birds, usually found in small parties feeding in or close to trees and bushes. They are mainly brown with differing rump colours, and are best distinguished by their calls and behaviour. The sexes are similar. There are 11 species, found only in Australia.

Acanthizidae (bristlebirds, scrub wrens, fairy warblers, thornbills, whitefaces; order Passeriformes) Family of birds with thin, pointed bills with basal bristles, all of which build domed nests. They are insectivorous and vary from strictly arboreal (fairy warblers) to ground-feeding (scrub wrens). The sexes are usually similar. There are 17 genera, comprising 63 species. They are found mainly in Australia and New Guinea.

Acanthobdellida (phylum Annelida, class Hirudinea) Order of parasitic annelid worms that lack an

anterior sucker. Bristles occur in the anterior region. There is one genus, *Acanthobdella*, that occurs only on salmon.

Acanthocephala Phylum of bilaterally symmetrical, worm-like organisms with elongate bodies which may show poor segmentation. Most do not have an excretory system, and all lack a gut. A retractable proboscis is present. They are all endoparasitic, living in two or three marine or terrestrial vertebrates during their development. The phylum contains about 600 species.

Acanthochitonina (class Amphineura, subclass Polyplacophora, order Neoloricata) A suborder which contains the largest of all polyplacophorans, but small members also occur. Posterior valves may not be present. The girdle may envelop the valves totally. They first appeared in the Oligocene.

Acanthoclinidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of small (8 cm), agile fish inhabiting tropical waters of the Indo-Pacific region. They have pelvic fins reduced to one spine and two soft rays.

Acanthodii Class of primitive, fossil fish, characterized by the presence of a true bony skeleton, a heterocercal tail fin, a persistent notochord, ganoid scales, and stout spines in front of the fins. The Acanthodians lived from the Silurian to the Permian Period and may be related to ancestors of the more modern bony fish.

Acanthopagrus latus (Japanese silver bream) *See* Sparidae.

Acanthophthalmus kuhlii (kuhli loach) *See* Cobitidae.

Acanthopterygii Superorder of bony fish including all spiny-finned fish (e.g. Perciformes and Beryciformes).

acanthosoma *See* postlarva.

Acanthuridae (surgeonfish, doctorfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of slab-sided fish with a sharp spine on each side of the tailbase (hence the name 'surgeonfish'). The spine is retractable in some species. Many species exhibit striking colour patterns. There are about 80 species, found in all tropical seas, often feeding on organisms covering the surface of rocks, or on seagrasses.

Acanthus (family Acanthaceae) Genus of shrubs, most of which are xeromorphic and have spiny leaves. The upper lip of one corolla is lacking. The pattern for the decoration on Corinthian column capitals is supposedly based on the leaves of *A. spinosus*. There are 50 species, found in S. Europe (*A. mollis* is bear's breeches), Asia, and Africa (*A. ilicifolius* grows in mangrove swamps).

acari mites *See* Acarina.

Acarina (acari mites, ticks; class Arachnida) Order of small or very small arachnids that have a short, unsegmented abdomen. The body comprises three tagmata: the gnathosoma, the propodosoma (these two sometimes jointly called the protosoma), and the hysterosoma. The respiratory organs are tracheae. Many species are parasites of medical and veterinary importance, and many are agricultural pests. The Acarina are regarded by many zoologists as an unnatural, polyphyletic group comprising elements derived independently from different arachnid stocks. There are 20 000 known species, 2800 of which are aquatic, including some that are marine.

acarinum A small pouch in the abdomen of Old World carpenter bees of the genus *Xylocopa* (subgenus *Koptortosoma*), which provide protection for symbiotic mites of the genus *Dinogamasus*.

accentors *See* Prunellidae.

accessory genitalia (secondary genitalia) Organ of intromission, present only in the males of the order Odonata. It is situated on the sternites of the second and third abdominal segments. It has no homologues in the animal kingdom.

accessory respiratory organ A system of air chambers formed by outgrowths from the mouth or gill region of fish that occasionally leave their aquatic environment. The uptake of oxygen from the air is facilitated by a dense network of tiny blood vessels in the skin that lines these air chambers. Possession of these organs enables such fish as labyrinthfish (Anabantidae), snakeheads (Channidae), or air-breathing catfish (Clariidae) to survive outside water for some considerable time. The swimbladder also may serve as an accessory respiratory organ. *See also* air breathing in fish.

accidental species One of five classes of fidelity used by the Braun-Blanquet school of phytosociology in the description and classification of plant communities. Accidentals are rare species in the community, present either as chance invaders from another community or as relics from a previous community. *Compare* exclusive species; indifferent species; preferential species; and selective species.

Accipiter (sparrowhawks, goshawks; family Accipitridae) The largest genus of birds of prey, comprising small to medium-sized hawks. Broad wings and long tails enable them to pursue prey through the woodland in which they live, and where they feed on mammals, birds, reptiles, and insects. The females are often larger than the males. There are 47 species, whose distribution is cosmopolitan.

Accipitridae (hawks, eagles, buzzards, kites, Old World vultures; order Falconiformes) The largest family of birds of prey, with many genera cosmopolitan in their distribution, especially *Accipiter*, *Buteo*, *Circus*, *Elanus*, and *Haliaeetus*, which make up nearly half the family. Other genera are more restricted in range, and more than half are monotypic. They are generally carnivorous, preying on snails, insects, fish, mammals, reptiles, and birds; but one species, *Gypohierax angolensis* (palm-nut vulture), feeds on oil-palm husks. There are 63 genera, with more than 200 species.

acclimation Response by an animal that enables it to tolerate a change in a single factor (e.g. temperature) in its environment. Applied most commonly to animals used in laboratory experiments. *See* acclimatization.

acclimatization 1 Reversible, adaptive response that enables animals to tolerate environmental change (e.g. seasonal climatic change). The response is physiological, but may affect behaviour (e.g. when an animal responds physiologically to falling temperature in ways that make hibernation possible, and behaviourally by seeking a nesting site, nesting materials, and food). 2 (acclimation, hardening) Changes involving the synthesis of proteins, membranes, and metabolites that occur in a plant in response to chilling or freezing temperatures, which protect tissues or confer tolerance to the cold.

accumulated temperature Surplus or deficit of temperature with respect to a defined mean value and expressed as an accumulation over a given period, e.g. month, season, or year. For example, a datum value of 6 °C is used as a critical temperature for sustained vegetation growth.

accumulator Term used in plant-succession studies to describe a pioneer species whose activities are claimed to enrich the abiotic environment with nutrients.

-aceae Standardized suffix used to indicate a ranking of plants at the family level in the recognized code of classification, e.g. in 'Rosaceae', the rose family.

acellular slime moulds Slime moulds in which the feeding stage is a true plasmodium.

acentric Applied to a fragment of a chromosome, formed during cell division, that lacks a centromere. The fragment will be unable to follow the rest of the chromosome in migration towards one or other pole as it has lost its point of attachment to the spindle.

Acer (family Aceraceae) Genus of trees in which the leaves are without stipules, opposite, and entire or often palmately lobed, but rarely pinnate (e.g. they are in *A. negundo*, box elder). Regular, pentamerous flowers are borne in racemes, corymbs, or umbels. The fruit is a samara. These trees are important for timber; many are ornamentals; and maple syrup is obtained mainly from *A. saccharum*. Field maple (*A. campestre*) is wild in Britain; sycamore (*A. pseudoplatanus*), from S. Europe, is naturalized in Britain. There are about 200 species, mainly northern temperate, and a few in tropical mountains. China has 100–150 species.

Aceraceae Small family of two genera of trees, *Acer* and *Dipteronia* (which comprises two species found only in China). The family is related to Hippocastanaceae and Sapindaceae.

acervulus Asexual, conidia-bearing structure that is formed by certain fungi parasitic in plants. It consists of a mat of fungal tissue which bears a layer of conidiophores; initially formed within the plant tissues, it later breaks through to the surface to release conidia.

Acetabularia (mermaid's cup, mermaid's wineglass; family Dasycladaceae, order Dasycladales) Genus of algae in which the mature thallus consists of a single axis or 'stalk' with a gametangial disc at the top. Found in warm regions in shallow, sheltered seas, attached to rocks, shells, etc. Fossil *Acetabularia* dating from the Tertiary have been found.

acetabulum Socket in the pelvis into which the head of the femur fits.

acetic-acid bacterium Bacterium that produces acetic acid from ethanol (ethyl alcohol).

Acetobacter Genus of Gram-negative, aerobic bacteria not included in any taxonomic family. Cells are ovoid or rod-shaped, motile or non-motile. Certain species can oxidize ethanol (ethyl alcohol) to carbon dioxide, forming acetic acid as an intermediate. Some species are used in the manufacture of vinegar. They are found on fruits and vegetables, in alcoholic beverages, etc.

acetylcholine (ACh) The acetylated form of choline involved in synaptic transmission between nerve cells. It is released from vesicles by the presynaptic neurone and diffuses across the synaptic cleft where it interacts with specific receptors to produce a local depolarization of the post-synaptic membrane, thus enabling the transmission of nerve impulses.

acetylcholine esterase Enzyme present within the synaptic cleft that hydrolyses acetylcholine to choline and acetic acid, thus preparing the synapse for the passage of a new impulse.

acetyl coenzyme A Important intermediate in the citric-acid cycle, and in fatty-acid and amino-acid metabolism.

ACh *See* acetylcholine.

achene Small, single-seeded, dry, indehiscent fruit.

Acherontia atropos (death's head hawkmoth; order Lepidoptera, family Sphingidae) Very large moth whose common name is derived from the skull-like pattern on the thorax. It robs beehives of honey. The moth squeaks by forcibly expelling air through its proboscis. The larva is very large, green or purple, and feeds on Solanaceae. The species is found in Africa, Europe, and N. Asia.

Acheulean *See Homo erectus*.

achira (*Canna edulis*) *See Canna*.

Acholeplasma *See* Acholeplasmataceae.

Acholeplasmataceae (class Mollicutes) Family of Gram-negative, prokaryotic, chemo-organotrophic organisms that do not require the presence of sterols for growth. Cells are spherical, pleomorphic, or filamentous. They are found as parasites in a variety of mammals and birds. There is one genus (*Acholeplasma*), containing five species.

Achras (family Sapotaceae) Genus of plants. *A. zapota* (*Manilkara zapota*) yields the delicious fruit chiku, or sapodilla plum, for which it is now widely cultivated; and chicle, formerly the elastic component of chewing gum. There are four species, found in northern tropical America.

acicular Pointed or needle-shaped.

acid According to the Brønsted–Lowry theory, a substance that in solution liberates hydrogen ions or protons. The Lewis theory states that it is a substance that acts as an electron-pair acceptor. An

acid reacts with a base to give a salt and water (neutralization), and has a pH of less than 7.

acid-fast bacteria Certain bacteria of the order Actinomycetales, including *Mycobacterium*, which, after being treated with certain dyes, are not decolorized on subsequent treatment with a mineral acid.

acidic grassland Grassland that occurs on acidic soils: it is usually derived from former woodland as a consequence of centuries of grazing and, to a lesser extent, burning. In Britain and much of NW Europe the dominant grasses are species of *Agrostis* (bent) and *Festuca* (fescue). This type of vegetation is most extensive in upland areas, but the associated plant species tend to be different, and the name 'grass heath' is considered more appropriate.

acidophilic 1 Refers to the propensity of a cell, its components, or its products to become stained by an acidic dye. 2 *See* acidophilous.

acidophilous (acidophilic) Applied to 'acid-loving' organisms, i.e. organisms that grow best in acidic habitats.

acidopore *See* Formicinae.

acid rock Igneous rock containing more than about 60% silica by weight, most of the silica being in the form of silicate minerals, but with the excess of about 10% as free quartz. Typical acid rocks are granites, granodiorites, and rhyolites. The limits are somewhat arbitrary and there are a number of schemes.

acid soil Soil having a pH less than 7.0. Degrees of soil acidity are recognized. Soil is regarded as 'very acid' when the reaction is less than pH 5.0. The USDA lists five standard ranges of soil acidity (less than pH 4.5, extremely acid; 4.5–5.0, very strongly acid; 5.1–5.5, strongly acid; 5.6–6.0, medium acid; and 6.1–6.5, slightly acid). Surface soil horizons of acid brown earths have a reaction of pH 5.0 or less.

Acinonyx jubatus (cheetah) *See* Felidae.

Acipenseridae (sturgeons; class Osteichthyes, subclass Actinopterygii, order Acipenseriformes) Family of large, fairly sluggish, bottom-feeding fish with a low-slung mouth, toothless jaws, four barbels in front of the upper jaw, and rows of large plates along the body. Found in Europe and N. America. The majority of the 26 species are marine but ascend rivers to spawn. A few species, e.g. the sterlet (*Acipenser ruthenus*), live in fresh water, never reaching the sea. Sturgeons are very fertile, large females of the common sturgeon (*Acipenser sturio*) producing up to 6 000 000 eggs per year. The roe of ripe females after processing is renowned as caviar.

Acipenseriformes (class Osteichthyes, subclass Actinopterygii, superorder Chondrostei) Order of rather primitive fish characterized by a cartilaginous skeleton, a heterocercal tail-fin, and the head showing a pointy, protruding rostrum with a ventrally located mouth. Extant members of the order either have a naked skin or possess five rows of large, rhomboid, bony scales along the body; a spiral valve is found in the intestinal tract. Apart from the sturgeon and the paddlefish the order includes a number of fossil representatives dating back to the Carboniferous Period.

Acochlidiacea (phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods in which individuals are very small and benthic, living between sand grains. The visceral sac is thin and spiculate, and is often much longer than the foot and markedly separate from it. There is no shell. These gastropods are deposit feeders. According to some authorities the order contains three families; others include only one.

Acoela 1 (class Turbellaria, subclass Archoophora) Order of platyhelminth worms that have no gut cavity or pharynx. 2 (phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods that possess no shell, mantle cavity, or gills. Respiration is carried out by branchiae. Dorsal outgrowths are quite common, and all have undergone complete detorsion. Benthic and planktonic forms occur. There is only one fossil family recorded, which appeared in the Eocene. According to some authorities, the taxonomic use of 'Acoela' as a molluscan order is little accepted and should be discouraged. It represents an attempt to unite the Notaspidea and Nudibranchia.

Acoeloraphe (formerly *Paurotis*; family Palmae) Monotypic palm genus. *A. wrightii* is a low, clump-forming, monoecious, fan palm with greyish leaves, native to the Florida Everglades, and widely cultivated.

aconite *See Eranthis*.

acontium In Anthozoa, an extension of the mesentery-bearing nematocysts which lies in the gastric cavity but which can be protruded through the mouth in order to capture prey.

acorn barnacle *See Balanus balanoides*; and Balanidae.

acorn worms *See* Hemichordata.

Acorus (family Araceae) Genus of two species of warm temperate Asia. *A. calamus* (sweet flag), a marsh plant, is widely cultivated for its fragrant leaves and rhizomes with medicinal properties. The rhizomes are sympodial, the flowers bisexual.

acoustico-lateralis system Generally found in aquatic lower vertebrates (e.g. lampreys, sharks, bony fish, and one or two amphibians), it consists of the inner-ear region and the lateral-line organs located in the skin. Essentially a sensory system, it conveys environmental information to the brain of the vertebrate. Whereas the lateral-line organs respond to changes in water pressure and displacement, the inner ear responds to sound and gravity. *See* lateral line.

acquired characteristics Characteristics that are acquired in the lifetime of an organism, according to early evolutionary theorists such as Lamarck. Lamarck further suggested that traits acquired in one generation in response to environmental stimuli would be inherited by the next generation. Thus over several generations a particular type of organism would become better adapted to its

environment. The kinds of acquisition envisaged by Lamarck and their heritability are now discredited, although there has been a recent revival of some aspects in modified form.

Acrania (alternative name for Cephalochordata) *See* Branchiostomidae.

Acrasiales (subclass Acrasidae) Order of slime moulds with the characteristics of the subclass. The order contains two families and several species, but classification remains tentative. The organisms are found on dung, soil, decaying plant material, etc.

Acrasidae (class Acrasiomycetes) Subclass of slime moulds in which the myxamoebae have blunt, rounded pseudopodia. When aggregating to form a pseudoplasmodium, the myxamoebae do not collect into distinct streams. There is one order.

acrasin Chemotactic substance involved in the aggregation response of cellular slime moulds (Acrasiales). It is now known to be cyclic AMP.

Acrasiomycetes (division Myxomycota) Class of slime moulds in which the feeding stage generally consists of individual amoeboid cells (myxamoebae). Fruiting bodies are formed by aggregation of myxamoebae and differentiation of the resulting pseudoplasmodium. Acrasiomycetes are found in soil, decomposing plant material, etc.

acre Unit of area, the British statute acre being equal to 0.4047 hectares or 4840 square yards. In Britain, historically a woodland acre varied from forest to forest, but was always larger than the statute measure. Assarts were surveyed at the statute measure.

Acrididae (short-horned grasshoppers, locusts; order Orthoptera, suborder Caelifera) Cosmopolitan family of small to large, short-horned grasshoppers among which stridulation is common, the males and some females rubbing a row of pegs on the hind femora against a toughened vein of the forewing (tegmen). They have three-segmented tarsi and antennae that are shorter than the forefemora, and hind legs modified for jumping (saltatorial). There are tympanal organs (ears) at the base of the abdomen. The female has a short ovipositor and lays eggs in the soil, or sometimes in decayed wood. All species are plant feeders and a number are important agricultural pests, most notably the locusts. Lubber, spur-throated, slant-faced, and band-winged grasshoppers are members of the family, which is the largest of the Caelifera and contains some 10 000 known species.

Acridotheres (mynahs; family Sturnidae) Genus of generally black or dark-brown birds with white at the base of the primaries and at the tip of the tail. They nest in holes in trees, or in banks. They are relatively omnivorous and all species are commonly found in captivity; *Acridotheres tristis* (common mynah) has become semi-domesticated and has been introduced to Australia, New Zealand, and S. Africa. There are five species, found from S. Russia and China, and south across SE Asia to Celebes.

Acridotheres tristis (common mynah) *See Acridotheres.*

acrocarpous moss Type of moss in which the archegonia, and hence the capsules, are borne at the tips of stems or branches. Acrocarpous mosses usually show little or no branching and typically grow in erect tufts. *Compare* pleurocarpous moss.

acrocentric Applied to a chromosome with a centromere located nearer one end than the other. During the anaphase stage of cell division, movement of an acrocentric chromosome towards one pole results in the chromosome being shaped like a 'J', as opposed to the normal 'V' shape of a metacentric chromosome (in which the centromere is in the middle).

Acrocephalus (reed warblers; family Sylviidae) Genus of small, brown warblers, mainly inhabiting marshes, and sometimes included in Muscicapidae. They are mainly insectivorous, but sometimes eat seeds and berries. Their nests are suspended between stems of reeds and bushes. They have distinctive, loud, chattering songs. There are 26–30 species. Many are migratory, breeding in Eurasia and wintering in Africa and SE Asia.

Acrochordidae (wart snakes; order Squamata, suborder Serpentes (Ophidia)) Family of primitive snakes with ridged scales that do not overlap. There are nasal openings on top of the snout. Usually they are found in brackish water, but occasionally offshore. They rarely come on to land. There are two species, found in India, Sri Lanka, and some Indo-Australian islands.

acrodont Applied to the condition in which the teeth are fused to the bones, rather than being set in sockets in the bones (thecodont), or attached by one side to the inner surface of the bones (pleurodont). *See also* Rhynchocephalia.

Acroechinoidea (class Echinoidea) Name of a taxonomic rank between the subclass and superorder levels that comprises the monophyletic group composed of all Echinoidea except for the Echinothurioida.

acromion In Mammalia, a ventral extension of the spine of the scapula. It articulates with the clavicle if a clavicle is present.

acropetal Growing or developing upwards from the base or point of attachment, so that the oldest parts are at the base and the youngest are at the tip.

acropetal movement (basifugal movement) Movement of substances within the plant toward its root and shoot apices. *Compare* basipetal movement.

Acropomatidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Very small family of marine tropical (Indo-Pacific) fish, comprising only three species. A characteristic of this family is the anterior location, close to the pelvic-fin base, of the vent or anus.

acrosome Thin-walled vesicle that forms a cap on the head of a spermatozoon. On contact with an ovum it bursts, releasing powerful lytic enzymes which cause a localized softening of the vitelline membrane, thus facilitating fertilization.

acrostichoid *See Acrostichum*.

Acrostichum (family Pteridaceae) Genus of ferns in which the rhizome is creeping, the leaves are pinnate, and the upper pinnae are reduced and covered below by sporangia (the 'acrostichoid' condition, which also evolved independently in other ferns). There are three species, in mangrove forests throughout the tropics (*A. aureum* is the commonest).

Acrotretida (class Inarticulata) Order of brachiopods, consisting of two suborders, which are usually circular or semicircular in outline. The shell is either phosphatic or punctate calcareous. The pedicle opening is restricted to the pedicle valve. The beak is marginal to subcentral in position.

Acrotretidina (order Acrotretida) Suborder of inarticulate brachiopods with phosphatic shells. Throughout life they are attached to the sea-bed by a pedicle. They first appeared in the Lower Cambrian. There are three superfamilies, seven families and about 50 genera.

acrozone *See* range zone.

ACTH *See* adrenocorticotrophic hormone.

actin Globular protein of relative molecular mass 60 000 which is a major component of microfilaments generally, and which is especially important in the myofilaments of striated muscle cell.

Actiniaria (sea-anemones; subclass Zoantharia) Order of solitary polyps without skeletons, but with numerous tentacles and paired mesenteries. There are about 200 living genera, with 700 species.

Actinistia 1 Alternative name for the Crossopterygii. 2 Alternative name for a superorder of ancient, tassel-finned fish (Coelacanthimorpha) with only one living relative, *Latimeria chalumnae*, of E. Africa.

Actinoceratida (class Cephalopoda, subclass Nautiloidea) Order of predominantly orthoconic cephalopods that have large siphuncles. Large amounts of siphuncular and cameral deposits are present. Most are assumed to have been nektonic. It is a large order, ranging in age from Lower Ordovician to Lower Carboniferous.

actinolite Mineral, specific gravity 3.1–3.3, hardness 5.0–6.0, and with the chemical composition $Ca_2(MgFe)_5(Si_4O_{11})_2(OH)_2$, whose name is derived from the Greek word meaning 'ray stone'. It occurs widely in crystalline schists and is associated with tremolite, epidote, chlorite, and talc. It is bottle-green of varying shades, from light greenish-grey to dark green, with a vitreous lustre. It crystallizes in the monoclinic system. The crystals are simple, long, prismatic, acicular, rod-like forms, often fibrous and felted. It also forms aggregate masses with a splintery structure. Felted forms are used as a source of asbestos for insulation and fire-resistant materials.

actinomorphic Radially symmetrical, as is a daisy flower.

Actinomycetaceae (order Actinomycetales) Family of bacteria that form pleomorphic rods or filaments that fragment readily; no mycelium is formed. Species are aerobic, facultatively anaerobic, or anaerobic. There are five genera, with many species, found chiefly in the alimentary tract in man, other mammals, birds or insects; a few species are pathogenic.

Actinomycetales Order of (usually) Gram-positive bacteria most of which form branching filaments or mycelia. They are chemo-organotrophic, and most are aerobic. Most species are saprotrophic, but a few are pathogenic in plants or animals. There are eight families.

actinomycete Mycelium-forming bacterium of the order Actinomycetales.

actinomycosis Any disease of humans or other animals in which the causal agent is an actinomycete.

actinophage Virus that infects actinomycetes.

Actinoplanaceae (order Actinomycetales) Family of aerobic, mycelium-forming bacteria. Spores, which may be motile, are formed in closed sacs at the tips of hyphae held aloft from the substrate. They are saprotrophic and are found in soils rich in humus, and on dead plant or animal material. There are 10 genera, with many species.

Actinopodea (superclass Sarcodina) Class of protozoa that are typically spherical amoebae with radiating pseudopodia. They are found free-living in freshwater and marine environments.

Actinopodidae *See* trapdoor spiders.

Actinopterygii (ray-finned fish) A subclass of the Osteichthyes (bony fish), comprising the ray-finned fish, which include the majority of living bony fish of sea and fresh water. The fins are composed of a membranous web of skin supported by a varying number of spines and soft rays. This subclass includes a diversity of fish types, ranging from the sturgeon and paddlefish to the eel and tuna. They appeared first during the Devonian.

Actinostrobus (family Cupressaceae) Genus of gymnosperms, endemic to Australia, and found as emergent tree species on heaths and sands in the south and west. *A. pyramidalis* (swamp cypress) is a pyramidal conifer up to 4 m in height, with dense, bright-green foliage reaching to the ground. It is found in W. Australia and is now cultivated. There are three species.

Actinostrobus pyramidalis (swamp cypress) *See Actinostrobus*.

Actinotus (family Umbelliferae) Genus that is thought to link the evolution of endemic Australian genera of Umbelliferae to cosmopolitan genera. Known as 'flannel flowers', most members of the genus are biennial herbs found in areas of low fertility, and in some arid regions. There are 17 species found in Australia, and one in New Zealand.

action spectrum Graph of the efficiency of different wavelengths of light in promoting a given photoresponse, e.g. as in photosynthesis or phototropism.

activation energy (energy of activation) The energy that must be delivered to a system in order to increase the incidence within it of reactive molecules, thus initiating a reaction. It is an important feature of enzymes that they greatly lower the activation energy of many metabolic reactions.

activator Metal ion that functions in conjunction with either an enzyme or its substrate in order to bring about a reaction.

active immunity Resistance to a disease acquired by an animal as the result of the production of antibodies in response to antigens produced by the disease organism whilst inside the host animal.

active layer Seasonally thawed surface layer between a few centimetres and about 3 m thick, lying above the permanently frozen horizon in a periglacial environment. It may be subject to considerable expansion on freezing, especially if silt-sized particles dominate, with important engineering implications. *See also* Mollisols.

active pool The part of a biogeochemical cycle in which the nutrient element under consideration exchanges rapidly between the biotic and abiotic components. Usually it is smaller than the reservoir pool, and is sometimes referred to as the 'exchange' or 'cycling' pool.

active site Part of an enzyme molecule, the conformation of which is such that it binds to the substrate or substrates to form an enzyme–substrate complex. The conformation is not absolute and may alter according to reaction conditions.

active transport Transport of substances across a membrane against a concentration gradient. Such processes are energy-requiring, the source often being the hydrolysis of ATP.

actomyosin Complex of the proteins actin and myosin in an approximately 3 : 1 ratio. It is formed *in vivo* in muscle cells, or *in vitro* from purified extracts.

Aculeata (wasps, ants, bees; order Hymenoptera, suborder Apocrita) Division of apocritan Hymenoptera in which the ovipositor has lost its egg-laying function and is modified as a sting for the injection of venom. In hunting wasps this last function is used to paralyse, but not kill, insect or spider prey. The sting is also a means of defence, and this is its exclusive function in bees. The sting has been lost in some aculeates (e.g. formicine ants) and is reduced or absent in some bees (e.g. the Andrenidae and Meliponini). *Compare* Parasitica.

aculeate 1 Prickly, pointed. 2 Applied to organisms that are armed with a sting. 3 Applied to members of the hymenopteran division Aculeata (which have stings). The word is derived from the Latin *aculeatus*, meaning sting, from *acus*, needle.

acuminate Tapering to a point.

acute (of disease) Applied to a disease that develops rapidly and is of short duration; symptoms tend to be severe.

Adansonia (family Bombacaceae) Genus of trees, several species of which are pollinated by ants that inhabit modified spines. Baobab (*A. digitata*) is famous for its hugely swollen trunk, commonly 15 m girth, and reaching 35 m. Other species swell, but less so. Baobab provides human and animal food and medicines. There are ten species, occurring in the seasonal tropics of Africa, Madagascar, India, and Australia.

Adapidae (order Primates, suborder Prosimii, infra-order Lemuriformes) Extinct family of lemur-like animals. Most were small, but a few had heads 10 cm or more long. The brain case was small but with temporal crests, smooth cerebral hemispheres, and the tympanic ring was included in the bulla. Dentition was full and the incisors were not procumbent, but in *Adapis* species the canines were incisiform, the molars resembling those of some modern lemurs. The skeleton was adapted for grasping, leaping and perching. Old World adapids (e.g. *Adapis* and *Pronycticebus*) probably resembled lemurs and lorises, to which they may be ancestral. They were distributed in Europe and N. America in the Eocene.

adaptation 1 (ethol.) General term describing adjustments by animals in respect of their environments. The adjustments may occur by natural selection, i.e. as individuals with favourable genetically acquired traits breed more prolifically than those lacking these traits (genotypic adaptation), or they may involve non-genetic changes in individuals, such as physiological modification (e.g. acclimatization) or behavioural changes (phenotypic adaptation). 2 (evol.) That which fits an organism both generally and specifically to exploit a given environmental zone, e.g. wings allow birds to fly, while the hooked beak and sharp talons of birds of prey are more specialized adaptations well suited to a predatory way of life.

adaptive breakthrough Evolutionary change by the acquisition of a distinctive adaptation that permits a population or taxon to move from one adaptive zone to another. At the most extreme such moves might be from water to land, or from land to air.

adaptive pathway Series of small adaptive steps, rather than a single large one, which leads from one adaptive zone across an environmental and adaptive threshold into another adaptive zone. In effect, small changes accumulate so that the organism is virtually pre-adapted to enter the new zone.

adaptive peaks and valleys Symbolic contour map showing the Darwinian fitness or adaptive value of genotypic combinations will usually display adaptive peaks and valleys: these occur at points at which the fitness is respectively strong or weak. The distribution of the population of a given species will therefore coincide with that of the adaptive peaks.

adaptive radiation 1 A burst of evolution, with rapid divergence from a single ancestral form, resulting in the exploitation of an array of habitats. The term is applied at many taxonomic levels, e.g. the radiation of the mammals at the base of the Cenozoic is of ordinal status, whereas the radiation of 'Darwin's finches' in the Galápagos Islands resulted in a proliferation of species. 2 Term used synonymously with 'cladogenesis' by some authors.

adaptive type Population or taxon with distinctive adaptive attributes, expressed as a particular morphological theme, characteristic of a particular habitat or mode of life. In evolutionary terms, the appearance of a new adaptive type is frequently followed by radiations that yield variants that partition the environment and exploit it more effectively.

adaptive value (Darwinian fitness, selective value) The balance of genetic advantages and disadvantages that determines the ability of an individual organism (or genotype) to survive and reproduce in a given environment. The 'fittest' is the individual (or genotype) that produces the largest number of offspring that later reach reproductive maturity.

adaptive zone Comprises a taxon and the associated environmental regime or regimes, habitat, or niche. The adaptive specialization that fits the taxon to its environment may be narrow, as with the giant panda, which eats only certain types of bamboo shoots, or broad, as with the brown bear, which is omnivorous. In dietary terms, therefore, these two mammals occupy narrow and broad adaptive zones respectively.

adder *See Vipera berus*.

additive genetic variance *See* heritability.

adecticous *See* Coleoptera; and Hymenoptera.

Adeleina (order Eucoccidia) Suborder of parasitic protozoa characterized by the occurrence of syzygy. The parasites develop in epithelial cells and cells of the circulatory systems in vertebrate and invertebrate hosts. There are several families.

Adenanthera (family Leguminosae, subfamily Mimosoideae) Genus of trees, several of them common as shade trees. *A. pavonina* has hard, scarlet seeds, used for centuries in India and Sri Lanka as units in one of the oldest weight systems known, for weighing gold, etc. There are 12 species, occurring from S. China to the Pacific islands.

Adenanthos (family Proteaceae) Genus of shrubs with single flowers, often bright red. Height varies from that of a 3 m bush to prostrate forms. They are similar to *Grevillea*. There are 32 species, endemic to W. Australia.

adenine Purine base which occurs in both DNA and RNA.

adenosine Nucleoside formed when adenine is linked to ribose sugar.

adenosine diphosphate (ADP) High-energy phosphoric ester, or nucleotide, of the nucleoside adenosine. It can undergo hydrolysis to adenosine monophosphate and inorganic phosphate, the reaction releasing 34 kJ/mol of energy at pH 7.

adenosine triphosphate (ATP) High-energy phosphoric ester, or nucleotide, of the nucleoside adenosine which functions as the principal energy-carrying compound in the cells of all living organisms. Its hydrolysis to ADP and inorganic phosphate is accompanied by the release of a relatively large amount of free energy (34 kJ/mol at pH 7) which is used to drive many metabolic functions.

adenoviruses (Adenoviridae) Group (family) of viruses which contain linear, double-stranded DNA; the virion has icosahedral symmetry and is not enveloped. They are found in the respiratory tract of animals, and can cause disease.

ADH *See* vasopressin.

adherens junction Cell junction commonly observed in epithelial cells, e.g. those lining the intestine and those in cardiac muscle cells. At these junctions the plasma membranes of the neighbouring cells are separated by a space of 15–25 nm which is filled with a filamentous material. Beneath this, anchoring the junction to the cell cytoplasm, are loosely structured mats of fibres, 7 nm in diameter, thought to be actin filaments. It is thought that these junctions may provide mobility in the regions of the cells in which they are located.

adiabatic Applied to the changes in temperature, pressure, and volume in a parcel of air that occur as a consequence of the vertical movement of the air, and without any exchange of energy with the surrounding air. *See also* dry adiabatic lapse rate; and saturated adiabatic lapse rate.

Adiantaceae Family of ferns in which sori are borne on the undersides of the veins of the pinnules, without indusia. Their distribution is cosmopolitan but they occur most abundantly in the moist tropics. There are about 60 genera.

Adiantum (maidenhair ferns; family Adiantaceae) Genus of ferns in which all the fronds are alike, usually with black, glossy petioles and wide, fan-shaped leaflets. Rhizomes are scaly. Sori are borne near the vein ends on the reflexed tips of the leaflets. There are about 200 species. Most occur in the moist tropics and warm-temperate regions, as far as the southern British Isles.

adipose Pertaining to fat.

adipose eyelid The thickened yet transparent skin overlying the eyes of some animals, including some fish, such as certain herring and mullet species. Apart from a small central aperture, it covers most of the eye, giving the fish a 'bespectacled' appearance.

adipose fin In some fish, a type of second dorsal fin in the form of a small flap of skin tissue without supporting rays. Largely composed of fatty tissue covered with skin, it is found amongst members of the salmon, catfish, and a few other families.

adipose tissue Connective tissue containing large cells in which fat is stored.

admirals *See* Nymphalidae.

adnate 1 Applied to the gill of an agaric that is attached to the stipe by most or all of its width. 2 Applied to analogous close attachments of two organs in higher plants, e.g. of a leaf to a stem. *Compare* adnexed.

adnexed 1 Applied to the gill of an agaric that is attached to the stipe by only a part of its width. 2 Applied to analogous loose attachments of two organs in higher plants. *Compare* adnate.

adoral On the same side of the body as the mouth.

Adoxa *See* Adoxaceae.

Adoxaceae Family of one monotypic genus of obscure affinities, *Adoxa* (moschatel), of almost circumpolar distribution in the northern-hemisphere, cool-temperate woodlands. A herb 5–10 cm tall, with ternate leaves and a terminal inflorescence of four outward- and one upward-facing flowers which are five- or (in the terminal flower) four-lobed and light green; the ovary is inferior. The fruit is a drupe.

ADP *See* adenosine diphosphate.

adpressed stipules *See* stipule.

adrenal gland In vertebrates, an organ secreting certain hormones. Many vertebrates possess multiple adrenal glands, but in mammals there is one gland close to each kidney. In tetrapods, each gland consists of a central medulla and an outer cortex. The medulla secretes adrenalin and noradrenalin, hormones needed when the animal is in an excited state and must engage in strenuous activity (e.g. fighting or fleeing). The cortex secretes sex hormones and other hormones concerned with regulating the water and salt balances of the body.

adrenalin (adrenaline, epinephrine) Hormone secreted by the adrenal medulla and largely responsible for the 'fight or flight' response in mammals. It stimulates the breakdown of glycogen, thus raising the blood-sugar level, it mobilizes free fatty acids, and it has a variety of effects on the cardiovascular and muscular systems.

adrenergic system *See* neurotransmitter.

adrenocorticotrophic hormone (ACTH) A polypeptide hormone secreted by the anterior lobe of the pituitary gland which stimulates the synthesis and secretion of hormones by the adrenal cortex.

adret Applied to the south-facing slopes of Alpine valleys, which receive a high degree of insolation as a result of their aspect. Cultivation and settlement patterns often favour such slopes. *Compare* ubac.

Adriana (family Euphorbiaceae, tribe Crotoneae) Genus of dioecious shrubs with insignificant flowers. There are about five species, endemic to Australia, where they are found in central and southern regions.

adsorption The attachment of an ion, molecule, or compound to the charged surface of a particle, usually of clay or humus, where replacement or exchange may take place. Ions carrying positive charges (e.g. those of calcium, magnesium, sodium, and potassium) become attached to, or adsorbed by, negatively charged surfaces (e.g. those of clay or humus).

adsorption complex Various materials of the soil, mainly clay and humus and to a lesser degree other particles, capable of adsorbing ions and molecules.

advection The movement of one element (in climatology, a mass of air) relative to another, involving a transfer of heat.

adventitious Growing from an unusual position, e.g. roots from a leaf or stem.

advertisement Form of display in which an individual makes itself as conspicuous as possible. It is used most commonly by male animals holding a territory, in order to ward off rivals and to attract females.

-ae Suffix in occasional use, but not recommended by the codes of nomenclature, to indicate certain families of plants (*see* -aceae). Also used to indicate plant classes e.g. 'Angiospermae', the flowering plants.

Aechmea (family Bromeliaceae) Genus of epiphytes. A few of them, which have showy inflorescences, have now become house plants. *A. magdalenae* (pita) of Colombia, provides fibres for cloth and cordage. There are 150 species.

aecidiosorus *See* aecium.

aecidiospore *See* aeciospore.

aeciospore (aecidiospore) Spore produced by certain fungi of the order Uredinales. Chains of aeciospores are produced in an aecium which develops in the tissues of the host plant.

aecium (aecidiosorus) Structure formed by certain rust fungi (order Uredinales) in the tissues of a host plant. A mature aecium is often cup-shaped, with chains of spores (aeciospores) being produced from the base of the cup; in some rust fungi the aecium is a more diffuse structure.

aedeagus Intromittent organ or penis of males of most insect groups, which is of great diagnostic value in many groups. The inner wall of the aedeagus is a continuation of the ejaculatory duct and is usually called the endophallus. It may be inflatable and everted during copulation. It has a gonopore at its base and opens at its apex through a phallotreme, the whole structure being surrounded by a sclerotized cuticle. The endophallus may be armed with backward-directed teeth or spines which gain purchase on the vaginal walls of the female.

Aëdes aegypti (yellow-fever mosquito; order Diptera, family Culicidae) Cosmopolitan mosquito of the tropics and subtropics, where the females transmit the virus of yellow fever when they bite. It is a coastal and riverine species, and rarely breeds far from human habitations. The eggs are laid in small areas of stagnant water in tree holes, old tins, and bottles, or in broken coconut shells. The larvae are colourless, with a black respiratory siphon. The adult bears a characteristic, white, lyre-shaped mark on the dorsum of the thorax.

Aegeriidae *See* Sesiidae.

Aegiceras (family Myrsinaceae) Genus of small, shrubby trees. *A. corniculatum* grows in mangrove forest and is viviparous. The bark contains a saponin and is used as a fish poison. There are two species, found in the Old World tropics.

Aegithalidae (long-tailed tits, bushtits; order Passeriformes) Family of small titmice with medium to long tails. The nest is intricate and domed, with a small entrance, built in trees and bushes. There are three genera, with seven species.

egithalos (long-tailed tits) is a Eurasian genus, *altiparus* (bushtit) is an American genus, and *altria* (pygmy tit) is confined to Java.

egithalos (long-tailed tits) *See* Aegithalidae.

gle (family Rutaceae) Genus of three plant ecies. Bael fruit (*A. marmelos*) grows wild and is tensively cultivated in India, from where it has read to all of seasonal tropical Asia. It is highly nniferous and is a valuable remedy for dysentery.

egotheles (owlet-nightjars; family Aegothelidae) enus of brown-grey, secretive, nocturnal birds milar to Podargidae (frogmouths) and Caprimulgidae (nightjars). They are insectivorous, with mall, broad bills. They possess preen glands. They est in holes in trees or the ground. There are eight pecies, found in Australasia, (but not in New Zealand).

Aegothelidae (owlet-nightjars; order Caprimulgiformes) Family comprising only one genus, *Aegotheles*.

aeolian (eolian) Applied to the action of the wind at or near the Earth's surface. The resulting processes involve the erosion, transport, and deposition of material, and are at their most effective when the vegetation cover is discontinuous or absent.

Aepyceros melampus (impala) *See* Bovidae.

Aepyornithidae (elephant birds; order Aepyornithiformes) Extinct family of large, flightless, running birds, standing up to 3 m tall, and laying eggs more than 30 cm long. There were about eight species; their remains have been found in Madagascar.

aerenchyma In a plant, tissue containing large, intercellular air spaces.

aerial mycelium Part of a mycelium held aloft from the substrate.

aerobe Organism that can grow only in the presence of air, i.e. one that requires oxygen for growth.

aerobic 1 Of an environment: one in which air (oxygen) is present. 2 Of an organism: one requiring the presence of oxygen for growth, i.e. an aerobe. 3 Of a process: one that occurs only in the presence of oxygen.

aerodynamic method Method for monitoring rates of primary productivity, it is particularly useful in studies of woodland or forest communities. The carbon-dioxide concentration from ground level to above canopy height is measured at regular intervals, or continuously, by sensors attached to a mast. Differences in carbon-dioxide concentration reflect differences in rates of photosynthesis and respiration and hence in productivity. The chief advantages of this approach are that it is non-destructive and causes minimal disturbance to the environment of the vegetation being studied. Other non-destructive methods usually enclose the vegetation (e.g. in polythene or plexiglass chambers), which can make results unrepresentative of normal field conditions. *Compare* harvest methods, chlorophyll method, and gas-exchange method.

aerodynamic roughness Uneven flow of air caused by irregularities in the surface (which may be of a solid, or of air of different density) over which the flow takes place.

aerogenic Applied to bacteria that can produce gas during the metabolism of certain types of substrate.

aerological diagram Diagram to demonstrate variations with height of the physical characteristics of the atmosphere, particularly its temperature, pressure, and humidity.

aeropalynology The study of pollen grains and spores in the atmosphere. This is important for allergy studies (e.g. of hay fever), and for understanding the spread of diseases in man, other animals, and agricultural plants, and recently for palaeoecologists attempting to improve the interpretation of microfossil data.

aerosol Colloidal substance, either natural or man-made, that is suspended in the air.

aerotaxis Change in direction of locomotion, in a motile organism or cell, made in response to a change in the concentration of oxygen in its immediate environment.

aerotolerant Applied to organisms (usually bacteria) that, although normally anaerobic, are not killed by the presence of air.

Aeschynanthus (family Gesneriaceae) Genus of herbs, bole climbers, or epiphytes, often with fleshy leaves. The flowers are vivid red, strongly protandrous, and bird-pollinated. There are 80 species, found in forest undergrowth from warm-temperate China to tropical SE Asia.

Aeschynomene (family Leguminosae, subfamily Papilionatae) Genus of 150 species of tropical and subtropical plants. The wood of *A. aspersa* (shola) is used for pith-helmets.

Aesculapian snake *See Elaphe longissima*.

Aesculus (horse chestnut, buckeye; family Hippocastanaceae) Genus of deciduous trees with large, sticky buds, opposite palmate leaves, and showy terminal panicles of white or red flowers. There are about 25 species, found in deciduous forests of SE Europe, E. Asia, and N. America. They are much cultivated.

Aeshna cyanea (blue aeshna, southern hawker) *See* Aeshnidae.

Aeshnidae (dragonflies, order Odonata, suborder Anisoptera) Family of ubiquitous, large, swift-flying, hawker dragonflies which are strikingly marked with blue or green. They have similar triangles in the fore- and hindwings, a well defined but small anal loop in the hindwings, the eyes broadly contiguous across the top of the head, the ocelli in a triangle around a raised tubercle, and the ovipositor complete and not projecting beyond the long anal appendages. The nymphs are unmistakable, having large eyes and slender bodies. More than 430 extant species have been described, and their distribution is cosmopolitan. *Aeshna cyanea* (blue aeshna, southern hawker) is a large, inquisitive dragonfly which is often encountered along

tracks and hedgerows in rural areas, and may occur far from water, in towns and gardens. It is the commonest of the large hawker dragonflies of Europe. In the male there is a well defined T-shaped black spot on the front of the head, with the sides of the thorax having broad, apple-green stripes, and the abdomen being spotted with green and blue. The female has similar green thoracic stripes and the abdomen is patterned with yellow and green on a brown background. The terminal segments contain blue in the male and green in the female. Both sexes have two broad, green, antehumeral stripes. The species occurs throughout Eurasia and N. Africa.

aestival In the early summer. The term is used with reference to the six-part division of the year used by ecologists, especially in relation to the study of terrestrial and freshwater communities. *Compare* autumnal; hibernal; prevernal; serotinal; and vernal.

aestivation (estivation) 1 Phenomenon characteristic of some warm-desert animals that survive long periods of extreme hot weather by sleeping underground or in some shaded location. It is analogous to hibernation in cold environments. Some freshwater fish, e.g. the lungfish *Lepidosiren paradoxa* and *Protopterus annectus*, burrow into soft mud at the beginning of the dry season. In some species (e.g. *P. annectus*) the combination of dried-up mud, mucus, and skin produces a thin cocoon covering the whole fish except the mouth, so that the fish can still breathe air from the tube-shaped burrow. Aestivation normally lasts the length of the dry season. 2 The arrangement of sepals and petals in a flower bud.

Aetapcus vincenti (smooth prowfish) *See* Pataecidae.

aethalium In certain myxomycetes, a sessile fruiting body consisting of masses of spores contained within a surface crust.

Aëtosauria Mainly Triassic group of primitive thecodontian ('tooth-in-socket') reptiles. They resembled heavily armoured crocodiles, and appear to have been specialized herbivores or possibly omnivores. They grew up to 3 m long, and their armour plating comprised rows of bony plates.

Aëxtoxicon (family Aëxtoxicaceae) Genus of one species, a large tree of the warm temperate rain forests of Chile. The leaves are (sub)opposite, and lepidote. Flowers are borne in axillary racemes, and are unisexual, and pentamerous. The fruit is a drupe. Probably they are related to the Monimiaceae; and formerly they were placed incorrectly in the Euphorbiaceae.

afference Reception by the brain of signals originating in sensory organs.

affinity index Measure of the relative similarity of composition of two samples, e.g. $A = c/\sqrt{(a+b)}$ where a and b are the numbers of species in one sample but not in the other and vice versa respectively, and c is the number of species common to both. The reciprocal, $\sqrt{(a+b)}/c$, indicates the ecological and phytosociological distance (D) between samples.

afforestation 1 The establishment of woodland by natural succession or by the planting of trees on land where they did not grow formerly. 2 Historically, the act of defining an area of land that henceforth would become subject to forest laws.

aflatoxin One of a group of toxins produced by fungi of the genus *Aspergillus*. The toxins have carcinogenic and other toxic properties. Feedstuffs contaminated with aflatoxins have caused severe outbreaks of disease among farm livestock.

African bass *See* piassava.

African–Indian desert floral region Part of the African subkingdom of Good's (1974) Palaeotropical kingdom. The flora is relatively poor and specialized, the number of endemic genera probably just exceeding 50. *Phoenix dactylifera* (the date palm) belongs to this region, but, not surprisingly perhaps, there are no garden plants.

African lungfish *See* Protopteridae.

African oak *See* Ochnaceae.

African rain forest Rain forest occurs in tropical lowlands where rainfall is heavy and where there is little or no dry season. Floristically four main regions of the rain forest are recognized: the African, American, Indo-Malaysian, and the Australasian. These regions share few woody species and genera in common.

African walnut (*Coula edulis*) *See* Olacaceae.

Afro-alpine vegetation On the highest mountains of Africa, above the dwarf or elfin woodlands, are found shrublands and grasslands. These are alpine in character (hence the term 'Afro-alpine') and besides containing plants found at lower altitudes in middle and high latitudes, they also include endemics, e.g. the giant lobelias and groundsels on Ruwenzori and Kilimanjaro.

afrormosia Important, attractive hardwood from western tropical Africa, produced by *Pericopsis elata*.

agamete In Mesozoa, a reproductive body which divides to form a daughter within the body of the parent.

agamic generation (asexual generation) In cynipid, heterogynous wasps, parthenogenetically reproducing females that are genetically diploid. The unfertilized eggs laid may be male (having undergone meiosis, or reduction-division) or female (not having undergone meiosis). Agamic females usually emerge from stout galls designed to overwinter or to survive a period of scarce resources.

Agamidae (agamids; order Squamata, suborder Sauria (Lacertilia)) Family of lizards that closely resemble iguanas, but that have acrodont teeth. Scales are keeled and often spiny. Typically they have a large head, long limbs, and a long tail with no autotomy. Dorsal crests, throat sacs, and colour change are common. The family includes bipedal and gliding forms. There are 300 species, all found in the Old World. *See Amphibolurus barbatus*; *Chlamydosaurus kingii*; *Draco volans*; *Moloch horridus*; and *Uromastyx*.

agamospermy *See* apomixis.

Agaonidae (fig wasps; suborder Apocrita, superfamily Chalcidoidea) Family of small or minute, sexually dimorphic, black, chalcidoid wasps which live within the flowers on fig trees and help pollinate them, the males rarely emerging from the fruits. The head of the winged female is long and somewhat oblong with a deep, median, longitudinal groove; males are nearly always wingless. The front and middle legs are stout, and the front tibiae have no spurs. The hind legs are slender. The males have thick antennae, with 3–9 segments. Mating occurs within flowers and there is often fighting between males.

agar Complex polysaccharide obtained from certain types of seaweed. When heated with water and subsequently cooled to about 45 °C, agar readily forms a gel (jelly); an agar gel supplemented with nutrients is used widely as a medium for the culture of bacteria and other micro-organisms.

agaric Any fungus that forms an umbrella-shaped or mushroom-like fruit body.

Agaricaceae (order Agaricales) Family of fungi in which the spores in masses appear dark brown or black. The stipe breaks cleanly from the pileus and typically bears a ring. The gills are pinkish when young, becoming dark brown to black as they mature. There are three genera, including the edible mushroom. They are saprotrophic, and are found on the ground in grassland, woods, etc.

Agaricales (subclass Holobasidiomycetidae) Order of fungi that typically form fleshy fruit bodies in which single-celled basidia are formed. There are many families; the order includes most of the mushrooms and 'toadstools'. Most members of the order are saprotrophic, and found on wood, soil, dung, etc. They are important agents of decay.

agaricide Natural or synthetic chemical substance that is toxic to agarics, the fungal group including mushrooms and 'toadstools'.

Agaricus (family Agaricaceae) Genus of fungi which includes the cultivated mushroom, *A. bisporus*, as well as several edible wild species; there are also some poisonous species. They are found on the ground in fields, woods, etc., and are cosmopolitan in distribution. *See also* field mushroom; horse mushroom; and wood mushroom.

agarophyte Seaweed from which agar can be obtained.

Agathis (kauri, kauri pines, Manila copal; family Araucariaceae) Genus of large, coniferous trees with broad, elliptical leaves; valuable, pale, light timber; and resin (Manila copal) in the bark. There are 13 species, found in tropical to warm-temperate forests. They are native from Malesia to Queensland and New Zealand. *See also* dammar.

Agavaceae Family of monocotyledons, some woody. Most are robust rosettes, but a few are trees or climbers. The leaves are crowded, strap-like, many-spined, succulent. Inflorescences are racemose; the flowers usually bisexual; the perianth united; the ovary superior or inferior, and trilocular. The fruit is a capsule or berry. Several produce tough fibres. There are about 20 genera, with 700 species; they are found in the tropics and subtropics, mainly in arid regions.

Agave (family Agavaceae) Genus of rosettes, producing after many years a terminal inflorescence, and then dying. *A. americana*, the century plant, provides the Mexican beverage pulque, and its juice may be distilled to produce mescal. Several *Agave* species provide fibres, e.g. sisal hemp, istle fibre. There are 300 species, found in subtropical and tropical parts of arid America.

age (of woodland) The time that has elapsed since the area was first wooded, irrespective of clear felling and of any changes in the type of woodland. The term does not refer to the age of existing trees.

age-and-area hypothesis J. C. Willis suggested in 1922 that, all other things being equal, the area occupied by a taxon is directly proportional to the age of that taxon. Thus in a polytypic genus, the species with the smallest area of distribution would be the youngest in the genus. However, things hardly ever are equal, and Willis's ideas have never gained acceptance as a law or rule.

age determination (in fish) The age of fish with a bony skeleton and scales can be determined by studying the number of annual rings found in certain parts of the fish. Although those in the scales are most frequently used, other structures, such as otoliths, finrays, dentary bones, and vertebrae are also analysed for this purpose.

Agelena (common grass spiders) *See* Agelenidae.

Agelenidae (sheet-web spiders; order Araneae, suborder Araneomorphae) Family of spiders that construct sheet webs with lateral, tubular retreats, and that have a somewhat elongate appearance, with a flattened thorax. The sternum is wide, heart-shaped, and may project between the fourth coxae. The chelicerae are usually very convex, and nearly vertical, the outer margin with three teeth, the inner with 2–8 teeth. The carapace is oval, narrowed, and anteriad; and has a longitudinal depression (sometimes replaced by a dark line), with patterns of dots and bars. The head is raised and narrow, and points forward, with the eyes, usually uniform in size, arranged in two short rows. The legs are thin and long, are covered thickly with long hairs, and are spiny, especially on the third and fourth pairs. The anterior spinnerets are cylindrical, and more or less separated; the median spinnerets are similar or smaller; and the posterior spinnerets are usually two-segmented and long. The tracheal spiracle is close to the spinnerets. All species in this family, which includes the common grass spiders of the genus *Agelena*, and *Tegenaria domestica* (house spider), catch prey on the upper surface of the sheet web. *Argyroneta* (water spider) is usually placed in this family, but sometimes in a family of its own. Many species spend a long time together as couples. Distribution is worldwide.

Ageneiosidae (barbel-less catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes)

Family of freshwater fish found in tropical South America. About 25 species are known.

ageostrophic wind The vector difference between the geostrophic and the actual winds. *See also* geostrophic wind.

age pigment The dark-pigmented material, also known as lipofuscin, that accumulates in older animal cells. It may be partly responsible for the ageing of such cells.

age polyethism *See* polyethism.

agglomerate Coarse-grained volcanic rock with rounded to subangular fragments. These fragments are mainly larger than 2 cm in size, but the mixture of fragments is typically ill sorted and the matrix may be fine-grained. An agglomerate is the product of a volcanic explosion and is therefore a pyroclastic rock.

agglomerative method System of hierarchical classification that proceeds by grouping together the most similar individuals, and subsequently groups, into progressively larger and more heterogeneous units. At each stage the groups or individuals linked are those giving the minimum increase in group heterogeneity.

agglutin *See* blood group.

agglutination Clumping of cells caused by the reaction between antigens on their surfaces and antibodies in their external environment.

agglutinogen *See* blood group.

aggradation The general accumulation of unconsolidated sediments on a surface, which thereby raise its level. A large range of mechanisms may be involved, including fluvial, aeolian, marine, and slope processes.

aggregate Group of soil particles adhering together in a cluster; the smallest structural unit, or ped, of soil. Aggregates join together to make up the major structural units.

aggregation 1 (pedol.) Process in which soil particles coalesce and adhere to form soil aggregates. The process is encouraged by the presence of bonding agents such as organic substances, clay, iron oxides, and ions, e.g. calcium and magnesium. 2 (ethol.) Group of animals that occurs when individuals are attracted to an environmental resource. The term does not imply any social organization. 3 (atmos.) Progressive attachment of particles (e.g. ice or snow) or droplets around a nucleus, thereby causing its growth.

aggregation pheromone *See* pheromones.

aggressin Toxic substance that is produced by certain micro-organisms pathogenic in animals or humans. Aggressins inhibit the defence mechanisms of the host organism.

aggression Behaviour in an animal that serves to intimidate or injure another animal, but that is not connected with predation.

agistment The letting of grazing rights, particularly in woodland.

Aglaia (family Meliaceae) Genus of plants, most of which are medium-sized trees. They have twigs with stellate hairs, and leaves that are large and pinnate (or, rarely, simple). The flowers are tiny, borne in panicles, and often fragrant. The fruit is one- or few-seeded, the pericarp leathery and dehiscent, the seed large, with a fleshy jacket. A few members of this genus are timber species (including the former genus *Amoora*). There are 250–300 species, occurring from China to the Pacific.

Aglais urticae (small tortoiseshell butterfly; order Lepidoptera, family Nymphalidae) A butterfly in which the ground colour of the wings is a red-orange; markings are black, yellow, and blue. Adults overwinter and emerge in February or March. Larvae feed on nettles, feeding in groups until the last instar. There are several subspecies. The species is found throughout Europe, including Britain, and in temperate Asia.

Agnatha (Marsipobranchii; phylum Chordata, subphylum Vertebrata) Superclass of jawless, fish-like vertebrates, with sucker-like mouths, including the extant lampreys, slime-eels and hagfish. Lacking paired fins, the Agnatha include some of the earliest primitive vertebrates, e.g. *Cephalaspis*, *Pteraspis*, and *Jamoytius*. They appeared first during the Ordovician, and in the Upper Palaeozoic they developed heavily armoured forms (e.g. *Cephalaspis* and *Pteraspis*).

Agonidae (poachers; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of small, marine, cold-water fish, with an elongated body, and narrow tapering tail. The pogge (*Agonis cataphractus*) of W. Europe reaches a maximum length of 20 cm. There are about 20 genera.

Agonis (family Myrtaceae, subfamily Leptospermoideae) Genus of shrubs and trees with alternate leaves, and five-petalled, usually white flowers. *Agonis flexuosa* (willow peppermint) is widely cultivated. There are 12 species, endemic to Australia, where they are found in areas of low fertility, including eucalyptus forests, mainly in the west.

Agonis cataphractus (pogge) *See* Agonidae.

Agonis flexuosa (willow peppermint) *See Agonis*.

agonistic Describes behaviour between two rival individuals of the same species that may involve aggression, threat, appeasement, or avoidance, or that may be ritualized (e.g. as bird song, or as certain forms of display). Agonistic behaviour often arises from a conflict between aggression and fear.

agouti *See* Dasyproctidae.

agric horizon Mineral-soil diagnostic horizon formed from accumulation of clay, silt, and humus, which has moved down from an overlying, cultivated soil layer. It is a soil horizon created by agricultural management, and is identified by its near-surface position, and by colloids accumulated in the pores of the soil. (USDA term.)

agriforestry *See* agroforestry; and agrisilviculture.

Agriidae *See* Calopterygidae.

Agrimonia (family Rosaceae) Genus of perennial herbs with pinnate leaves having small leaflets alternating with the larger pairs, and long racemes

of five-petalled flowers with many stamens; the receptacle bears hooked spines that persist and become woody in fruit, as does the deeply-hollowed receptacle. There are about 15 species, occuring in the northern temperate zone, and in S. America.

Agriochoeridae (order Ruminantia, infra-order Tylopoda) Extinct family of N. American ruminants closely related to the pig-like oreodonts, but more slightly built, and with more primitive features, e.g. a long tail and clawed feet. They lived from the Upper Eocene into the Miocene, and, judging by their claws, inhabited trees or dug for roots and tubers.

Agriotherium Genus of primitive Ursidae (bears), probably related most closely to the giant panda (*Ailuropoda*). Its remains have been found in Europe and N. America (Pliocene and Pleistocene) and recently, more unexpectedly, at an early Pliocene site in S. Africa, making this Africa's only bear.

agrisilviculture *See* agroforestry.

Agrobacterium (family Rhizobiaceae) Genus of bacteria most of which are capable of causing the formation of galls in plants. No species can fix atmospheric nitrogen. *A. tumefaciens* causes crown gall in many types of plant and is a serious plant pathogen in many parts of the world. These bacteria are found also in soil.

agro-ecosystem An agricultural ecosystem, e.g. a cereal crop.

agroforestry (agriforestry) System of mixed arable farming and forestry, recently designed for tropical developing areas, especially rainforest environments. The scheme is based on traditional shifting-cultivation methods; but in the fallow woodland phase, land is planted with a commercial crop, e.g. rubber, instead of being abandoned to regenerate naturally. Alternatively, tree crops are interspersed with food crop patches on a continuous basis. The system ensures a continuous food supply, some continuous economic return, and the avoidance of soil degradation by exposure to tropical sunlight and rainfall during prolonged clearance; and it is suitable for small-scale family farmers.

agrometeorology The study of the relationship between conditions in the surface layers of the atmosphere and those in the surface of the Earth, as this affects agriculture.

Agromyzidae (leaf-mining flies; class Insecta, order Diptera, suborder Cyclorrapha) Relatively large family of small, phytophagous flies, which are difficult to define. The adults are small, with the costa of the wing broken where Sc or R_1 runs out. The females have an oviscapt. The third antennal segment is short, rounded, and rarely has a sharp point. The arista is hairy or bare. The lower fronto-orbital bristles are incurved; vibrissae are present; and the tibia is without pre-apical bristles. The costal vein is incomplete, being broken some distance from its junction with the upper margin of vein 1, and continued as far as the apex of vein 3. The ovipositor has a non-retractile sheath comprising the fused seventh abdominal tergite and sternite. The larvae are leaf-miners, stem-borers, or gall-causers; and are sometimes pests of garden plants and some trees, although they are of no great economic importance. Those of *Phytomyza ilicis* cause the familiar yellow blotching of holly leaves. They have a worldwide distribution, and 2300 species have been described. *See also* venation.

agronomy Branch of agriculture concerned with the theoretical and practical production of crops, and with the management of soils.

Agrostis tenuis *See* heavy-metal tolerance.

Agulhas current Part of the large-scale circulation of the S. Indian Ocean. It is a surface-water current that flows off the east coast of southern Africa between latitudes 25 °S and 40 °S in a south-westerly direction. Flow velocity varies seasonally between 20 and 60 cm/s.

ahermatypic Applied to corals that lack zooxanthellae and that are not reef-forming. Modern scleractinian corals are less restricted environmentally than those that form reefs, and are thus also known as 'deep-sea' corals.

AHG (antihaemophilic globulin) *See* blood clotting.

Ailurus fulgens (red panda) *See* Procyonidae.

Aimophila (American sparrows; family Emberizidae) Genus of mostly nondescript, brown, ground-feeding seed-eaters which nest on or close to the ground. There are 14 species, found in N. and C. America, with two species in S. America.

air bladder *See* swimbladder.

air breathing in fish A number of tropical freshwater fish possess accessory breathing organs which enable them to acquire atmospheric oxygen and stay out of water for some time. In some fish, e.g. *Anabas testudineus* (climbing perch) and *Clarias lazera* (catfish), the air taken up reaches richly vascularized chambers formed by modifications of the pharynx or the gill chambers. In some loaches even parts of the intestines are used for respiration. Other fish, such as lungfish, can breathe air because of the presence of primitive lungs.

air mass (airmass) Large body of air (sometimes of oceanic or continental proportions) identified primarily by an approximately constant wet-bulb-potential temperature. Temperature and humidity characteristics of an air mass, which are roughly the same within the one air mass at a particular latitude and height, are modified by and modify the atmospheric environment through which the air mass passes.

air sac In birds, a thin-walled extension of the lung which penetrates into the body cavity, entering the bones and forming air spaces. The lightweight bones that result are particularly important to birds. Anhimidae (screamers) have air spaces that penetrate to the tibia.

Aitken nuclei counter Device for the estimation of the concentration of particles with radii of more than 0.001 μm in a sample of air. Air is made to expand in a chamber: this causes it to cool. Water

vapour in it condenses on to particles, forming a mist whose opacity allows estimation of the particles present. *See also* Aitken nucleus.

Aitken nucleus Suspended, atmospheric, solid particle with a radius of less than 0.2 μm. Most Aitken nuclei are about 0.5 μm. On average, their concentration varies from less than 1000/cm^3 over oceans to 150 000/cm^3 in urban areas. *See* Aitken nuclei counter; and nucleus.

Aizoaceae Family of herbs or low shrubs with fleshy, undivided leaves, and showy flowers, which are regular, with many petals. They occur in temperate southern continents including Australia, but the family is most developed in S. Africa. Hottentot figs (*Carpobrotus*) of S. Africa are often cultivated as ornamentals, and have edible fruits.

Ajacicyathida (class Monocyathea (Regulares)) Order of Lower and Middle Cambrian archaeocyathids. They were usually solitary. The cylindrical or conical cup consists of two porous walls, the pores often being complex. The intervallum contains plane septa, or septa and tabulae, or radial links. Dissepiments or synapticulae are sometimes developed. The order contains four suborders and 58 families.

Ajuga (family Labiateae) Genus of herbs many of which have radical leaves forming a rosette. The leaves are simple or lobed, sometimes toothed, without stipules. The flowers are in at least two or many flowered whorls, often forming a terminal inflorescence. They are bisexual, with five fused sepals forming a toothed bell shape. The corolla has a short upper lip, and a larger, three-lobed lower lip with a ring of hairs in the corolla tube. The stamens are attached to the corolla tube. The ovary is superior, with two bilocular carpels and four ovules. The fruit is an oval nutlet. There are approximately 45 species, found throughout the world in a wide variety of habitats.

akinete Thick-walled resting cell formed by certain cyanobacteria. Akinetes can survive unfavourable environmental conditions and can germinate to produce new vegetative growth.

ala (pl. alae) Wing- or auricle-like projection present on the dorsal margin of some pelecypods. Alae may occur above the hinge margin on the anterior or posterior regions, or on both.

alabaster *See* gypsum.

alamiqui (*Solenodon*) *See* Solenodontidae.

alan *See Shorea albida*.

Alangiaceae Family of small trees, whose affinities are obscure. The leaves are exstipulate, alternate, and simple. The flowers are cymose, regular, and bisexual. There are 4–40 sepals, petals, and stamens. Petals are sometimes basally fused. The ovary may be superior or inferior, and unilocular; with one pendulous ovule, and a disc present. The fruit is a drupe, and has a fleshy endosperm. The family is tropical. *Alangium* contains about 20 Old World species; *Matteniusa* contains three species found in northern S. America.

alanine Aliphatic, non-polar amino acid, classed as non-essential in the diet of animals because it can be synthesized in sufficient amounts within cells.

Alaria (order Laminariales) Genus of brown algae, in which the thallus consists of a branched, root-like holdfast, a short stipe, and a thin, leaf-like blade with a pronounced midrib. During the summer, spores are produced in characteristic club-shaped 'leaflets' arising from the short stipe. There are several species; only *A. esculenta* (dabberlocks) occurs in Britain. *Alaria* species are found attached to rocks at and below low-water mark, often on very exposed shores.

alarm response Signals emitted by an animal that serve to warn others of a danger the individual has perceived. The signals may be visual (e.g. the white tail of a rabbit, displayed when running), aural (e.g. the call of a member of a flock of ground-feeding birds), or olfactory (among some fish and invertebrates).

alarm substance Substance released from the skin of injured fish. It causes an immediate alarm reaction among fish nearby, leading to a breaking up of a school formed by members of the same species. Originally discovered in minnows and other Cyprinidae, the alarm substance is probably present in several fish families.

Alaska current Oceanic water boundary current produced by the deflection of the N. Pacific current by the N. American continent. It flows in a north-easterly direction along the south-eastern margin of Alaska.

alastrim (variola minor) Mild form of smallpox in which there is a sparse rash and low-grade fever; mortality is very low. It is caused by the variola minor virus, a poxvirus.

alate Winged, or having appendages resembling wings.

Alaudidae (larks; order Passeriformes) Family of small, grey-brown and buff birds, their colours adapted to suit their environments. They have long, sharp, hind claws that help them to walk and run rather than hop. They are renowned for their song, delivered from a perch or in flight. They are seed and insect eaters. There are 15 genera, with 77 species, found in most of the Old World, with *Eremophila alpestris* (shore lark or horned lark) found also in N. America and Mexico.

A layer *See* emergents.

albacore (*Thunnus alalunga*) *See* Scombridae.

albatrosses *See Diomedea*; Diomedeidae; and Procellariiformes.

albedo The proportion of insolation that is reflected back from the Earth, from the tops of the clouds, and from the atmosphere, without heating the receiving surface. It averages about 30%, but varies widely according to the substance and texture of the surface, and the angle and wavelength of the incident radiation. The value for green grass and forest is 8–27% (over 30% for yellowing deciduous forest in autumn); for cities and rock surfaces, 12–18% (over 40% for chalk and light-coloured

rock and buildings); for sand up to 40%; for fresh, flat snow up to 90%; and for calm water only 2% in the case of vertically incident radiation, but up to 78% where there is a low angle of incidence. The albedo for cloud surfaces averages 55%, but can be up to 80% for thick stratocumulus.

Alberta low Storms common in Alberta, Canada, and associated with heavy rain and snow. The storms form as a result of cyclone regeneration after passage over the Canadian Rockies: as they move eastwards they bring very cold conditions, with blizzards.

Albian Stage in the Cretaceous, underlain by the Aptian, and overlain by the Cenomanian. It is known to contain a great variety of molluscs, with the gastropods in particular being useful zonal indicators between continents. The Gault and Speaton Clays of England are Albian.

albic Applied to an almost white soil in which there is little clay or oxides coating the sandy or silty particles. In the Soil Classification System of the National Co-operative Soil Survey in the USA, the albic horizon lies at or below the surface.

albinism 1 In animals, the heritable condition observed as the inability to form melanin (a dark-coloured pigment) in the hair, skin, or vascular coat of the eyes. It is due to a deficiency in the enzyme tyrosinase, and is usually inherited as an autosomal recessive. 2 In plants, a deficiency of chromoplasts, carotenoid-containing plastids that colour ripe fruits and flowers.

albite Important rock-forming mineral, specific gravity 2.61, hardness 6.0–6.5, chemical composition $Na(AlSi_3O_8)$. It is the end member of the plagioclase group of feldspars, and one of the commonest feldspars, occurring widely in acid igneous rocks, e.g. granites, rhyolites, and pegmatites. It is normally white in colour, sometimes greyish-white, and sometimes tinged red, with a vitreous lustre. It crystallizes in the triclinic system. The crystals are tabular, or tabular prismatic, but occur more often as irregular grains.

Albizia (family Leguminosae, subfamily Mimosoideae) Genus of tropical plants, sometimes known (incorrectly) as *Albizzia*. The subfamily Mimosoideae was ranked formerly as a family, Mimosaceae. It comprises shrubs and trees with feathery leaves and fluffy yellow flower heads, similar to *Acacia* (to which the genus is closely related). Several species are valuable timber trees. There are 10–12 species, occurring in Australia.

Albuginaceae (order Peronosporales) Family of fungi which are obligate parasites of flowering plants, causing diseases known as 'white rust' or 'white blister'. Sporangiophores develop beneath the host epidermis, causing it to swell and burst. The white powdery sporangia are then dispersed by wind. There is one genus.

Albugo (family Albuginaceae) Genus of fungi with the characteristics of the family. *A. candida* is a parasite of crucifers and is particularly common on *Capsella bursa-pastoris* (shepherd's purse).

Albulidae (bonefish; class Osteichthyes, subclass Actinopterygii, order Elopiformes) A family that includes only two extant species of marine tropical fish, both of which reach lengths of up to 1 m. Bonefish are considered a superb sportfish by anglers and are also caught in large numbers by beach seine nets in the Pacific region. The most common species, *Albula vulpes*, occurs in most tropical seas.

albumin Water-soluble, globular, simple protein that occurs in a variety of tissue fluids, including plasma, synovial fluid, tears, egg white, lymph, and cerebrospinal fluid. Its functions appear to be primarily those of osmotic regulation and the transportation of materials.

Alcedinidae (kingfishers; order Coraciiformes) Family of brightly coloured birds with large heads, short necks, and compact bodies. They have short, rounded wings, and a short tail. The bill is long, straight, and massive; the toes syndactyl. The sexes are usually alike. They are found in riverine and terrestrial habitats, feeding on fish, insects, and small vertebrates. There are 14 genera, with 84 species, of which the best known are *Alcedo atthis* (common kingfisher) and *Dacelo novaeguineae* (kookaburra). They are found worldwide. *See also* syndactylous.

Alcedo (kingfishers; family Alcedinidae) Genus of small kingfishers, with blue upper-parts, and chestnut or white under-parts. A brilliant blue line down the back and rump shows in flight. They are fish-eating and riverine, nesting in burrows. There are nine species, found throughout African, Palaearctic, and Oriental regions, and also in New Guinea.

Alcedo atthis (common kingfisher) *See* Alcedinidae.

Alces alces (American elk, European moose) *See* Cervidae.

Alchemilla (lady's mantles; family Rosaceae) Genus of herbs and low shrubs in which the stipules are leaf-like; the leaves alternate, palmately-veined or lobed; and the flowers green, small, with four sepals, borne in cymes, with no petals. An epicalyx of four lobes is present. There are four or five stamens. The fruit is dry, and formed from the single carpel. Many apomictic species occur in Europe, and several local endemics in E. Africa. They occur in open, grassy habitats. Some are cultivated. There are about 200 species, found in the northern temperate zone, and in the mountains of tropical Africa.

Alcidae (auks; order Charadriiformes) Family of mainly black and white, small-winged, diving seabirds. The legs are set well back; the feet are webbed. Bills vary from long and pointed to laterally compressed and high. Auks are mainly pelagic and gregarious, breeding in burrows or crevices, or on open cliff ledges, usually colonially. *Brachyramphus marmoratus* (marbled murrelet) breeds on forest branches. Auks feed on fish and invertebrates. *Pinguinus impennis* (great auk) is

extinct. There are 12–14 genera, with 22 species, found in northern regions of the Pacific and Atlantic, and in the arctic.

Alcippe (fulvettas, nun babblers; family Timalidae) Genus of small, short-billed birds, brown and grey in colour, some marked with chestnut, yellow, black, and white. They are generally solitary, and most inhabit forests. They are insectivorous, but also feed on snails and berries. There are 17–18 species, found mainly in SE Asia, with two species occurring in Africa.

alcohol Hydrocarbon in which a hydrogen atom is substituted by a hydroxyl (OH) group. An alcohol is designated as primary, secondary, or tertiary, according to whether the carbon to which the hydroxyl group is attached is bound to one, two, or three other carbons.

alcrete *See* duricrust.

Alcyonacea (soft corals; subclass Octocorallia) Order of corals which appeared first in the Lower Jurassic and which contains the modern genus *Alcyonium* (dead man's fingers). Members of the order are characterized by having retractable polyps with eight branching tentacles; the polyps are embedded in the body mass, which has a skeleton of numerous, free, calcareous spicules. Usually these corals are attached to rocks. The order contains six families, with 36 genera.

Alcyonaria Alternative name for the anthozoan subclass Octocorallia.

aldehyde Organic compound that contains the group CHO.

alder *See Alnus*.

alderflies *See* Megaloptera; and Sialidae.

aldose Monosaccharide or its derivative that contains an aldehyde group.

aldosterone Steroid hormone synthesized by the adrenal cortex, which influences electrolyte balance by promoting the retention by the body of sodium ions and the excretion of those of potassium; it also affects the rate of carbohydrate metabolism.

aldotriose Three-carbon monosaccharide containing an aldehyde group.

Alectis indicus (plumed trevally) *See* Carangidae.

Alectoris (partridges; family Phasianidae) Genus of medium-sized, rotund, short-tailed game birds with red bills and legs, and strikingly barred flanks. They prefer to run rather than fly, are ground-nesting, and inhabit mountainous regions and open country. There are seven species, found in Europe, Asia, and N. Africa. *A. rufa* (red-legged partridge) has been introduced in Britain.

Alectoris rufa (red-legged partridge) *See Alectoris*.

-ales Standardized suffix used to indicate an order of plants, e.g. 'Filicales', the ferns.

Aleuria (order Pezizales) Genus of fungi which typically form large, saucer-like, bright orange or yellow apothecia on the ground in woods, fields, etc. *A. aurantia* is the commonest of the three British species, and is found on soil in woods, lawns, grass verges, etc. in autumn.

aleuriospore 1 Thick-walled, single-celled, asexual fungal spore formed terminally on an aerial hypha. 2 Asexual spore that is liberated only on breakage of the hypha which bears it.

Aleurites (family Euphorbiaceae) Genus of trees producing fruits that are large and round, with a thick, fleshy pericarp, and that contain a few big, very hard, oily seeds. *A. moluccana* (candlenut), of Malesia provides oil for candles, soaps, paints, and varnishes. *A. fordii* and two relatives (sometimes called *Vernicia*), of China, provide tung oil for varnishes and paints. There are five species, occurring from tropical Asia to the Pacific.

Aleutian current *See* subarctic current.

Aleutian low Region of the N. Pacific, near the Aleutian Islands, where the average value of atmospheric pressure is low, owing to the frequency of low-pressure systems (cyclones) moving into and occupying the region. Any one of these systems, when present on an individual day, may be called 'an Aleutian low'. Some of them are intense, others much less so. The term is the Pacific equivalent of 'Iceland low', used in the Atlantic.

alevin Term used by fisheries biologists to indicate the yolk-bearing larvae of the various salmon and trout species.

alexanders (*Smyrnium olusatrum*) *See Smyrnium*.

alexandrite *See* chrysoberyl.

Aleyrodidae (whitefly; order Hemiptera, suborder Homoptera) Family of small, sap-sucking insects in which all generations and both sexes are similar. Immature stages are immobile, and the last nymphal instar is very like the pupa of higher insects. There are about 1200 species, distributed worldwide.

alfalfa (lucerne) *See Medicago sativa sativa*.

alfalfa leaf-cutter bee *See Megachile rotundata*; and Megachilidae.

Alfisols (grey-brown podzolics) Mineral soils grouped as an order of the USDA Soil Taxonomy. These soils have clay-enriched or argillic B horizons; are alkaline to intermediate in reaction, with the base saturation in the B horizon more than 35%; are usually derived from base-rich parent materials; and are drier than −15 bars moisture potential for at least three months when plants could grow.

alfousinos *See* Berycidae.

alga Common (non-taxonomic) name for a relatively simple type of plant which is never differentiated into root, stem and leaves; which contains chlorophyll *a* as the primary photosynthetic pigment; which has no true vascular system; and in which there is no sterile layer of cells surrounding the reproductive organs. The algae range in form from single cells to plants many metres in length; algae can be found in most habitats on Earth, although the majority occur in freshwater or marine environments.

algal bloom Sudden growth of algae in an aquatic ecosystem. It can occur naturally in spring or early summer when primary production exceeds consumption by aquatic herbivores. Algal blooms may also be induced by nutrient enrichment of waters due to pollution. They are a characteristic symptom of eutrophication.

algin Salt (usually the sodium salt) of alginic acid, a complex polysaccharide present in the cell walls and between the cells in brown seaweeds (Phaeophyceae). When extracted from the seaweed and mixed with water, many algins make very thick, viscous solutions. They have a number of commercial uses, e.g. as stabilizers in ice-cream and other foods, and as suspending agents in paints and pharmaceutical preparations.

algology *See* phycology.

alimentary canal In animals, a tube along which food passes and through parts of whose walls nutrients are absorbed into the body. In some animals (e.g. Coelenterata) the canal has a single opening; in most animals it has two—a mouth through which food enters, and an anus through which unabsorbed material leaves the body.

alisphenoid Bone forming part of the wall of the skull.

alisphenoid canal In some Carnivora, a channel running through the alisphenoid bone which carries a branch of the external carotid artery.

alivincular Applied to one of the types of pelecypod ligament, which is positioned between the cardinal areas of the two valves, and is non-elongate.

alkali bee *See Nomia melanderi*; and Halictidae.

alkaline rock Igneous rock containing a relatively high concentration of the alkali and alkaline earth elements. Both silica-saturated and silica-undersaturated varieties exist, reflected by the presence of alkali feldspars and feldspathoids respectively. Alkali ferro-magnesian minerals are usually present, and their identity depends on the composition of the rock. Igneous rocks of the alkaline suite span the composition range from basic to acid, and may be intrusive or extrusive.

alkaline soil Soil with a pH greater than 7.0. Degrees of soil alkalinity are recognized. The USDA lists soils with a pH 7.4–7.8 as mildly alkaline; 7.9–8.4 as moderately alkaline; 8.5–9.0 as strongly alkaline; and more than 9.0 as very strongly alkaline. Soil is not regarded as highly alkaline unless the reaction is between 8.0 and 10.0. The full range of the pH scale (0–14) is not used in soils, as the reaction of most soils is between pH 3.5 and pH 10.0. Base saturation of 100% indicates a pH of about 7.0 or higher.

alkaloid One of a group of basic, nitrogenous, normally heterocyclic compounds of a complex nature. Alkaloids are derived from plants, and have powerful pharmacological effects.

alkanets *See Anchusa*.

Allamanda (family Apocynaceae) Neotropical genus of 15 species of plants. *A. cathartica*, a sarmentose shrub with showy yellow flowers, is now widely cultivated.

allanite *See* orthite.

allantoic bladder In vertebrates, a sac formed from the posterior region of the alimentary canal, functioning as a urinary bladder in amphibians, receiving metabolic wastes in embryonic reptiles and birds, and forming part of the placenta in Eutheria.

allantoic placenta In Eutheria, a placenta formed from the allantois and interpenetrating foetal and maternal tissues.

allantois In tetrapod embryos, a sac formed by the outgrowth of the posterior ventral part of the gut, as a precocious urinary bladder. In reptiles and birds it grows to surround the embryo, lying between the yolk sac and shell; the blood vessels by which it is linked to the embryo provide the means of respiration, and the allantoic cavity receives metabolic wastes. Most of the allantois is left with the shell at hatching. In Eutheria the allantois forms part of the placenta, supplying it with blood for respiration, nutrition, and excretion, and the allantoic cavity may be small. Most of the allantois is detached from the embryo at birth.

Allantospermum (family Simaroubaceae) Genus of biggish trees in which the leaves are simple; the flowers are bisexual, and pentamerous; and the fruit is a capsule. There are four or five species occurring in Borneo, Malaya, and Madagascar: a remarkable disjunction in range.

Alle (little auk; family Alcidae) Monotypic genus, comprising *A. alle* (little auk or dovekie), a small, black and white seabird with a short, broad bill and a distensible throat pouch. It breeds in the high Arctic, in rock crevices, and lays a single egg. It moves south in winter. It feeds on plankton.

allele Common shortening of the term 'allelomorph'. One of two or more forms of a gene arising by mutation and occupying the same relative position (locus) on homologous chromosomes. When in the same cell, alleles may undergo pairing during meiosis. They may be distinguished by their differing effects on the phenotype. The existence of two forms of a gene may be termed 'diallelism', and of many forms, 'multiple allelism'. The commonness of an allele in a population is termed the 'allele frequency'.

allele frequency *See* allele.

allelomorph Term that is commonly shortened to 'allele'. *See* allele.

allelopathy Release into the environment by an organism of a chemical substance that acts as a germination or growth inhibitor to another organism. Typical substances include alkaloids, terpenoids, and phenolics. The phenomenon was described originally for heath and scrub communities, notably the Californian chaparral, but is now thought to be a widespread anti-competition mechanism in plants (e.g. barley inhibits competing weeds by means of root secretions). It is also found

in other organisms, e.g. antibiotics may be produced by fungi to inhibit competing bacteria, when the term 'antibiosis' may be used.

Allen's rule The disputed idea that a race of warm-blooded species in a cold climate typically has shorter protruding body parts (nose, ears, tail, and legs) relative to body size than another race of the same species in a warm climate. The varying wing lengths in gulls are said to support this view. The hypothesis is that long protruding parts emit more body heat, and so are disadvantageous in a cool environment, but advantageous in a warm environment. Critics point to many other adaptations for heat conservation which probably are more important, notably fat layers, feathers, fur, and behavioural adaptations to avoid extreme temperatures.

Allerød Late glacial (i.e. late Devensian) period marking a prolonged warmer oscillation or interstadial during the general phase of ice retreat in NW Europe. Radio-carbon dating suggests it lasted from about 12 000 BP to 10 800 BP. Pollen records for the NW European area indicate a cool temperate flora with birch (*Betula* species) widespread, in marked contrast to the preceding and following, colder, *Dryas*, phases.

Alleynia (*Syringaxon*) Small, solitary, rugose coral recorded from the Silurian of Europe and N. America. It was one of the earliest representatives of its order.

alliance In phytosociology, a grouping of closely related associations. *See also* plant association.

alligator gar (*Lepisosteus spatula*) *See* Lepisosteidae.

Alligatoridae (alligators, caimans; order Crocodilia) Crocodilian family whose members have a broad, flat snout in which the fourth tooth of the lower jaw fits into a pit in the upper jaw and cannot be seen when the mouth is closed. There are seven freshwater species, all occurring in the New World except *Alligator sinensis* (Chinese alligator).

Alligator mississippiensis (American alligator; order Crocodilia, family Alligatoridae) Species of relatively sluggish crocodilians with a maximum recorded length of 5.8 m. They move slowly on land, hissing if surprised. Their nest mound is guarded by the female and is opened as the young begin to 'peep' at the time of hatching. They occur in the southern USA.

alligators *See* Alligatoridae; and crocodilians.

Alligator sinensis (Chinese alligator) *See* Alligatoridae.

Allium (onions, garlic; family Liliaceae) Genus of bulbous herbs, all of which contain oils with a pungent onion or garlic odour. The leaves are undivided, parallel-veined, and all radical. The flowers are borne in umbels enclosed at first in a spathe, which later splits. The perianth consists of six free, equal segments, and six stamens. Bulbils often partly replace the flowers. The fruit is a three-celled capsule. Many species are cultivated as vegetables, or for their flowers. There are more than 500 species found in the north temperate zone, south to Mexico and Ethiopia.

allochthonous Not indigenous; acquired. In the earth sciences the term is applied to geological materials that originated at a distance from their present position. Such displacement may be due to lateral thrusting and overfolding, or to gravity gliding. *Compare* autochthonous.

allogenic Applied to successional change due to a change in abiotic environmental conditions. *Compare* autogenic; *see also* succession.

allogenic stream Stream originating outside a particular area and whose continuation is inconsistent with its new surroundings. Type examples are the Nile and Indus, whose discharges are sufficient to carry them through arid regions, and the Yugoslav Neretva, which is large enough to pass over permeable limestone.

allograft Graft of tissue from a donor of one genotype to a host of a different genotype but of the same species. If the graft takes place from one part to another part of the same individual it is called an autograft.

allogrooming Grooming performed by one animal upon another animal of the same species. *Compare* autogrooming.

allometry Differential rate of growth such that the size of one part (or more) of the body changes in proportion to another part, or to the whole body, but at a constant exponential rate. For example, the extinct Irish elk (*Megaloceros giganteus*) was the largest of all cervids, but its antlers grew 2.5 times faster than the rest of its body to reach an adult span of up to 3.5 m in the largest individuals. Allometry may in other cases be negative, leading to comparatively smaller parts. *See also* Cervidae.

allopatric Applied to species that occupy separate habitats and that do not occur together in nature. *Compare* sympatric.

allopatric speciation Formation of new species from the ancestral species as a result of the geographical separation or fragmentation of the breeding population. Separation may be due to climatic change, causing the gradual fragmentation of the population in a few surviving favourable areas (e.g. during glaciation or developing aridity), or may arise from the chance migration of individuals across a major dispersal barrier. Genetic divergence in the newly isolated daughter populations ultimately leads to new species; divergence may be gradual or, according to punctuationist models, very rapid.

allopatry The occurrence of species in different geographical regions. The differences between closely related species usually decrease (i.e. the characteristics converge) when species are separated, in a process called character displacement, which may be morphological or ecological. *Compare* sympatry.

allopolyploid Polyploid formed from the union of genetically distinct chromosome sets (usually from different species). Examples are cultivated wheats.

allosteric effect The binding of a ligand to one site on a protein molecule such that the properties of

another site on the same protein are affected. Some enzymes are allosteric proteins, and their activity is regulated through the binding to an allosteric site of an effector.

allothetic Applied to information concerning an animal's orientation in an environment obtained by the animal from external spatial clues. *Compare* idiothetic.

Allotriognathi Alternative name for fish now placed in the order Lampridiformes.

allspice (*Pimenta dioica*) *See Pimenta*.

alluvial Applied to the environments, action, and products of rivers or streams. Alluvial deposits (alluvium) are clastic, detrital materials transported by a stream or river and deposited over the river floodplain. The term is also applied to surface flow, as in alluvial fans, bajadas, etc.

alluvial fan Mass of sediment deposited at some point at which there is a sharp decrease in gradient, e.g. between a mountain range and a plain. Essentially, a fan is the land-bound equivalent of a river-delta formation.

alluvium *See* alluvial.

almandine Member of the garnet group of minerals: specific gravity is 4.25, hardness 6.5–7.5, chemical composition $Fe_3Al_2(SiO_4)_3$. It is widely distributed in metamorphic and igneous rocks, and also in beach sands and placers. Its colour is red, brown-red, or black, and it has a greasy to vitreous lustre. It crystallizes in the cubic system. The most common forms of the crystals are rhombododecahedra, and many are irregular grains. Fine crystals are used as gemstones, and the mineral is useful in general as an abrasive.

almond *See Amygdalus*.

Alnus (alder; family Betulaceae) Genus of deciduous trees which are common in wet places. The roots have nitrogen-fixing nodules. The leaves are simple; the flowers are unisexual and borne in catkins, the female flowers developing into a woody, persistent, cone-like structure. The trees are useful for timber and as ornamentals. There are 35 species, occurring in the north temperate zone, extending south to the Himalayas and Andes. *See also* Frankiaceae.

Alocasia (family Araceae) Genus of rhizomatous herbs. The stems and leaves of *A. macrorhiza* (giant taro) are edible, but are grown nowadays mainly for pig food. There are 70 species, found in the eastern tropics.

aloeswood (eaglewood) *See Aquilaria*.

Alopecurus myosuroides (black grass) *See* herbicide.

Alopex (fox) *See* Canidae.

Alouatta (howler monkeys) *See* Cebidae.

alpha amino acid Amino acid in which the amino group is attached to the number-two, or 'alpha' carbon, adjacent to the carboxyl group. Compounds of this type represent the basic building blocks of peptides and proteins.

alpha helix The right-handed, or less commonly left-handed, coil-like configuration of a polypeptide chain representing the secondary structure of some protein molecules, particularly the globular variety. The configuration is maintained through intrachain hydrogen bonding between >CO and >NH groups of peptide bonds.

alpha-mesohaline *See* brackish.

alphaviruses Group (genus) of viruses of the Togaviridae. Alphaviruses can multiply in insects (mosquitoes) and in vertebrates, and can cause encephalitis in certain animals including humans.

Alphitonia (family Rhamnaceae) Genus of small trees and shrubs, several species of which are fast-growing pioneers of secondary forest. There are 20 species, occurring in Malesia, Australia, and Polynesia.

alpine glow At sunset, beginning as the sun nears the horizon, mountains in the east, particularly if snow-covered, assume a series of colours changing from yellow-orange to a rosy pink, which finally becomes purplish. The same series of colours in reverse order is seen on mountains in the west at sunrise.

Alpine orogeny Period of mountain building that affected both northern and southern margins of the ancient Tethyan ocean. It began in the Triassic, but reached its high point during the Late Oligocene and Miocene. The Alps are an obvious testament to this orogeny, while the gentle folds of N. France, and the Weald and London Basin in England, reflect the outer effects of the 'Alpine storm'.

alpine salamander *See Salamandra atra*.

alpine zone Region that occurs above the tree-line and below the snow-line on temperate and tropical mountains. The vegetation is characterized by an absence of trees, and varies greatly with aspect, the greatest contrasts being between the wet side and the dry, leeward side of the mountains concerned. The elevation of the lower limit of the zone increases from about 1000 m above sea-level in Scotland, to over 2000 m in the Swiss Alps, and to 3700 m in the western Himalaya.

Alstonia (family Apocynaceae) Genus of small to big trees in which the crown is often pagoda-like, with distinct whorls of branches. The bole often has huge buttresses. The leaves are often whorled; the flowers are cymose. The fruits are paired, woody follicles, containing many seeds, and having a tuft of silky hairs at both ends. The timber is easily worked and is sometimes very light. The bark yields latex which is used in traditional medicine. There are 39 species, occurring in the Old World subtropics and tropics.

Alternanthera (family Amaranthaceae, tribe Gomphreneae) Genus of herbs and shrubs with a single ovule and bilocular stamens which distinguish them from other members of the large family. Some species are grown for their ornamental leaves. *A. sessilis* has fleshy leaves which are eaten in some tropical countries. The genus is cosmopolitan but

mainly subtropical, and six or seven species are endemic to Australia, where they are found in arid habitats.

Alternaria (class Hyphomycetes) Form-genus of fungi which form yellowish-brown conidia which are divided by transverse and longitudinal septa. There are many species, including a number of important plant pathogens.

alternation of generations Alternate development of two types of individual in the life cycle of an organism. Usually one type reproduces asexually and the other sexually. In mosses and vascular plants, for example, a haploid phase, during which gametes are produced by mitosis (gametophyte phase), alternates with a spore-producing diploid (sporophyte) phase. In mosses the gametophyte is the dominant and conspicuous generation, whereas in higher plants it is the sporophyte that forms the conspicuous plant. In animals the alternation is found in coelenterates which possess a sexual medusoid and an asexual hydroid phase. In many parasitic protozoa (e.g. the malaria parasite *Trypanosoma*) the sexual phase is in one host and the asexual phase in another.

Althaea (marsh mallow, hollyhock, etc.; family Malvaceae) Genus of herbs with showy, regular, five-petalled flowers and an epicalyx of 6–9 segments joined below into a cup-like involucre hiding the calyx. Several species (e.g. *A. rosea*, hollyhock) are cultivated for their flowers or (e.g. *A. officinalis*, marsh mallow) for the mucilage used in confectionery or medicine. There are about 15 species occurring in temperate Eurasia, and in N. Africa.

Althaea officinalis (marsh mallow) *See Althaea*; and Malvaceae.

Althaea rosea (hollyhock) *See Althaea*; and Malvaceae.

Altingia (family Hamamelidaceae) Genus of trees which produce valuable timber. The buds are scaly; the flowers unisexual, very reduced, and borne in small heads. The fruits form as rounded, woody heads, and are dehiscent, containing many winged seeds. There are seven species, occurring from Assam and S. China to Java.

altiplanation Process of relief reduction or planation under periglacial conditions. Two mechanisms are involved: destruction of upstanding relief features by gelifraction, and accumulation of debris in depressions. In many areas only partial altiplanation has been achieved, with the emergence of altiplanation terraces, such as those of Cox Tor (Dartmoor, England).

altitudinal vegetation zones With increased altitude conditions usually become cooler and damper, so that the vegetation of mountains of considerable elevation show a corresponding zonation. In the tropics the zonation may extend from rain forest on the lower slopes, to alpine communities at heights above about 3500 m. On the other hand, in progressively higher latitudes the elevation of the tree-line gradually descends, eventually to sea-level.

altocumulus From the Latin *altum*, height, and *cumulus*, heap, a genus of cloud consisting of grey-white sheets or banded layers and rolls which may also be broken up into cells, composed largely of water droplets. Sometimes it has a banded appearance, occasionally giving a mackerel-sky effect, which is probably associated with strong vertical wind shear in middle altitudes. *See also* cloud classification.

altostratus From the Latin *altum*, height, and *stratus*, spread out, a genus of cloud consisting of greyish sheets or layers; the cloud may be striated, fibrous, or uniform. It may be composed of ice crystals as well as water droplets. *See also* cloud classification.

altruism Sacrifice, if necessary of life itself, so that others, commonly offspring or otherwise genetically close younger relatives, may survive or otherwise benefit. On the face of it this seems to reduce the 'fitness' of the altruist. However, by saving offspring at the cost of his own life, the altruist may 'save' more of his genes than if the situation were reversed, particularly if the reproductive potential of the altruist is exhausted, or nearly so.

Alucitidae (many-plumed moths; order Lepidoptera) Small family of fairly small moths in which the forewing is divided into six plumes and the hindwing into six or seven. They are not closely related to the Pterophoridae, which are also plumed. The larvae burrow into shoots, buds, and flowers, and may induce gall-formation. They have a worldwide distribution.

aluminosilicates Aluminium silicates with the composition Al_2SiO_5. They are found mainly in metamorphosed argillaceous rocks and their polymorphs, as andalusite, kyanite, mullite, and sillimanite, and are stable over a different range of temperatures and pressures, each indicative of different grades of metamorphism. Of the four, andalusite, sillimanite, and mullite form orthorhombic crystals, while kyanite commonly occurs as blue triclinic crystals. Andalusite occurs in low-grade metamorphic rocks; sillimanite and kyanite in high-grade metamorphic rocks; and mullite as fine needles in pelitic xenoliths which have been heated to approximately 1300 °C within basic igneous rocks.

alumstone *See* alunite.

alunite (alumstone) Mineral, specific gravity 2.7, hardness 3.5, and with the chemical composition $KAl_3(SO_4)_2(OH)_6$. It usually occurs as a secondary mineral in areas of volcanic rocks containing potassic feldspars which have been altered by sulphuric-acid solutions. It is very similar to dolomite, anhydrite, and magnesite, but it has a slightly astringent taste. Its colour is usually white or grey, and sometimes reddish, with a white streak and a vitreous lustre. It crystallizes in the trigonal system. The crystals are normally rare, and the mineral usually occurs in massive form.

Aluteridae *See* Balistidae.

alveolus 1 In the lung of an air-breathing vertebrate, a thin-walled sac surrounded by blood vessels through whose surfaces gas exchange occurs. 2 A sac forming an internal termination of a glandular duct. 3 The socket in a jaw bone into which a tooth fits. 4. *See* Rectangulata.

Alytes obstetricans (midwife toad; order Anura (Salientia), family Discoglossidae) Species of toad which lives in hilly terrain, hiding in crevices and under stones. It has a squat grey body with a whitish belly, and is up to 5.7 cm long. It has no vocal sacs. The male winds a band of eggs round his back legs while mating and carries them until hatching occurs. The toad is found in western and central Europe.

Alyxia (family Apocynaceae) Genus of about 80 species of shrubs found in Asia, Australia, and the SW Pacific, about nine species being endemic to Australia. They have small, five-petalled, white flowers, and fleshy, orange-red fruits.

Amandava (waxbills, munias; family Estrildidae) Genus of small, red-billed, finch-like birds, commonly kept in captivity. They inhabit tall grass and reeds, where they build untidy nests. *A. amandava* (red munia) is the only estrildid with a dull non-breeding plumage. There are three species found in India, SE Asia, and Africa.

Amandava amandava (red munia) *See Amandava*.

Amani sunbird (*Anthreptes pallidigaster*) *See Anthreptes*.

Amanita (family Amanitaceae) Genus of fungi which includes some of the most poisonous known (e.g. *Amanita phalloides*, *see* death cap; *Amanita virosa*, *see* destroying angel). A few species are edible. The fruit bodies are mushroom-shaped with white gills. Typically a volva is present, and remnants of the universal veil may adhere to the surface of the pileus. Some species form mycorrhizal associations with higher plants. *See also* blusher; Caesar's mushroom; false death cap; fly agaric; grisette; and panther cap.

Amanitaceae (order Agaricales) Family of fungi in which the fruit bodies are mushroom-like; the gills are not attached to the stipe, the stipe can be broken cleanly from the pileus, and both universal and partial veils are typically present. There are two genera. They are found on the ground, chiefly in woodland.

Amaranthaceae (cockscombs, celosias, etc.) Family of mostly annual herbs in which the leaves are entire, and without stipules. The flowers are small, borne in dense, spike-like cymes, and mostly unisexual; they have 3–5 scarious, green, or brightly coloured perianth segments; 3–5 stamens; and a one-celled ovary which forms a small, dry fruit. *Celosia cristata* (cockscomb) is cultivated for its red flowers. There are about 40 genera, with 500 species, mostly tropical or warm-temperate, but occurring as weeds in cooler regions.

Amaryllidaceae (daffodils, narcissi, etc.) Family of bulbous herbs which differ from Liliaceae only in the inferior ovary in their flowers. The flowers are solitary, or occur in umbels. The inflorescence is enclosed at first in a scarious spathe. The flowers are regular, and showy, with six similar perianth segments in two whorls, and sometimes with a trumpet-like corona. There are six stamens. Many species are cultivated for their flowers. There are about 60 genera, with 500 species, mainly of warm-temperate regions but extending into the tropical and cool-temperate zones.

Amatheusiinae Subfamily of the Nymphalidae.

amatoxins Poisonous substances present in the fruit bodies of certain species of *Amanita*. When eaten, amatoxins cause severe gastrointestinal symptoms and degeneration of liver and kidneys. They may be lethal even in small quantities.

Amazilia (hummingbirds; family Trochilidae) Largest genus of hummingbirds, comprising birds that are medium-sized, with bronze-green upperparts and rufous or white under-parts. They are nectar feeders, but will take insects. They breed all year round in tropical regions. There are about 31 species, found in S. and C. America, with two species reaching N. America.

Amazona (Amazon parrots; family Psittacidae) Genus of medium-sized, short-tailed, mainly green parrots. They feed on fruit and seeds, are hole-nesting, and are found in the forests of C. and S. America and the W. Indies. Many W. Indian species are endangered. *A. vittata* (Puerto Rican parrot) is nearly extinct. There are 27 species.

Amazon ant *See Polyergus rufescens*.

Amazona vittata (Puerto Rican parrot) *See Amazona*.

Amazon floral region Part of Good's (1974) Neotropical kingdom, corresponding to one of the formations of the rain forest. Because of extensive flooding by the Amazon river, the vegetation can be divided into that which is above the flood-level, called 'igapo', and that which is below it, called 'ete'. The flora is one of the richest in the world, and includes about 100 endemic genera, with 3000 endemic species, e.g. *Hevea brasiliensis* (Para rubber) and *Theobroma cacao* (cocoa).

Amazon parrots *See Amazona*.

Ambassis elongatus (yellowfin perchlet) *See* Centropomidae.

amberjack (*Seriola dumerili*) *See* Carangidae.

ambient pressure Atmospheric pressure in the surrounding air.

ambient temperature The dry-bulb temperature prevailing in the surrounding air.

ambivalent Applied to apparently confused behaviour by an animal, arising most commonly from conflict produced by impulses to behave in contradictory ways (e.g. to fight or to flee).

Amblycera (class Insecta, order Phthiraptera) Suborder of chewing lice, characterized by the pedunculate first flagellomere of the antenna, the groove of the head which conceals the antenna when at rest, the horizontal articulation of the mandibles, and the presence of maxillary palps.

Three of the constituent families parasitize only mammals, three only birds, and one parasitizes members of both classes. The lice eat feathers, skin, sebaceous exudates, or blood. Species in one genus, *Trochiloecetes*, have the mouthparts modified as piercing stylets (analogous to those of Anoplura) and feed on the blood of their hummingbird hosts. There are 75 genera, with about 850 species.

Amblycipitidae (torrent catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Small family of Asiatic freshwater fish inhabiting fast-flowing streams.

Amblydorus hancocki (grunting thorny catfish) *See* Doradidae.

Amblyopsidae (cavefish; class Osteichthyes, subclass Actinopterygii, order Percopsiformes) Family of small freshwater fish, (e.g. *Amblyopsis rosae* of the eastern USA) of interest mainly because most species are typical cave dwellers, lacking functional eyes and body pigment. There are about five species.

Amblypoda Term sometimes used synonymously with 'Pantodonta', but otherwise describing an order of large, archaic, and predominantly American ungulates comprising the four distinct suborders Pantodonta, Dinocerata, Xenungulata, and Pyrotheria. The Pantodonta culminated in the hippopotamus-like *Coryphodon*; the Dinocerata in *Uintatherium*, a grotesque animal resembling a rhinoceros in size and general appearance; the Xenungulata produced animals of similar size and build; and the Pyrotheria developed forms remarkably similar to early elephants.

Amblypygi (tailless whipscorpions, whipspiders; class Arachnida) Order of dark-coloured arachnids, in which the abdomen is flat, oval, without a telson, and lacking terminal flagellum, spray glands, and spinnerets. The first pair of legs is long, whip-like, and with many false segments; they are highly sensitive to touch and are used in water location and mating. The raptorial pedipalps are held parallel to the ground and their last two segments may be almost chelate. The chelicerae are subchelate. Amblypygids resemble spiders in many ways except for the long, whip-like first pair of walking legs, strong pedipalpi, and lack of spinnerets. Arthropod prey, e.g. cockroaches, crickets, beetles, and spiders, are impaled on the pedipalpal spines, pre-oral liquefaction presumably taking place. Amblypygids live in humid conditions under stones, logs, bark, and litter, and some are cavernicolous. The 60 or so species are divided between two families, and are tropical and subtropical in distribution.

Amblyrhynchus cristatus (marine iguana; order Squamata, suborder Sauria (Lacertilia), family Iguanidae) The only extant marine lizard. It feeds on seaweeds along the coasts of the Galapagos Islands, and basks on rocks or hides in fissures when not swimming. It attains lengths of up to 1.4 m and can weigh 10 kg.

amboyna Timber from *Pterocarpus indicus*. *See Pterocarpus*.

ambrosia beetle *See* Scolytidae.

ambrosia fungi Fungi which grow in the tunnels of wood-boring ambrosia beetles; the beetles use the fungi as food.

ambulacral Applied to those areas of the body of an echinoderm that bear tube feet.

ambulacral groove In Echinodermata, a linear depression on the body surface associated with a series of skeletal plates, the ambulacrum.

Ambystoma mexicanum (axolotl; order Urodela (Caudata), family Ambystomatidae) Species of neotenous salamander, normally breeding as an aquatic larva, but capable of metamorphosis into a terrestrial form. It is sexually dimorphic, the female being the larger, reaching up to 29 cm in length. Normally it is black but albinos are quite common. It is confined to certain lakes around Mexico City.

Ambystomatidae (mole salamanders, axolotls; order Urodela (Caudata), class Amphibia) Family of amphibians which have a broad head; the tongue free only at the sides; palatal teeth; costal grooves down the body; short, strong limbs; and a laterally compressed tail. Most burrow in earth for much of the year, but neotony is common in some species. There are more than 30 species, found in N. and C. America.

ameba *See* amoeba.

Amegilla *See* Anthophoridae.

Amelanchier (June berries; family Rosaceae) Genus of non-thorny, deciduous, small trees or shrubs with simple leaves, and flowers that are pentamerous, with 2–5 carpels, united to the receptacle below but free from it above, each carpel divided into two cells by a false septum. The flowers are also in racemes, distinguishing the genus from *Crataegus* and *Cotoneaster*. Several species are cultivated for their flowers, often becoming naturalized. There are about 25 species, occurring in the north temperate zone—most N. American, but some in Europe.

amensalism Interaction of species populations, in which one population is inhibited while the other is unaffected. *Compare* commensalism; competition; mutual inhibition; mutualism; neutralism; parasitism; predation; and protoco-operation; *see also* symbiosis.

American alligator *See Alligator mississippiensis*.

American cherry *See Prunus serotina*.

American cockroach *See Periplaneta americana*.

American cranberry (*Vaccinium macrocarpon*) *See Vaccinium*.

American flagfish (*Jordanella floridae*) *See* Cyprinodontidae.

American pitch pine (*Pinus palustris*) *See Pinus*.

American rain forest Like the other three regions of the rain forest, the American region is distinctive not by virtue of its physiognomic characteristics, but because of its floristic composition. For instance, of the non-tree plants, bromeliads and cacti are important, as well as the orchids and ferns that are more generally associated with the rain forest. *See also* African rain forest.

American red gum (*Liquidambar styraciflua*) *See Liquidambar*.

American red mason bee *See Osmia lignaria*.

American sap gum (*Liquidambar styraciflua*) *See Liquidambar*.

American sparrows *See Aimophila*.

American whitewood *See Liriodendron*.

amethyst *See* quartz.

Amherstia (family Caesalpiniaceae) Monotypic genus comprising *A. nobilis*, a small tree, cultivated for its racemes of spectacular, large, pink-red flowers and pinkish tassles of pendent young leaves. The stamens are fused as a tube. It is difficult to grow and is propagated by marcotting. It is native to Burma.

Amia calva (bowfin) *See* Amiidae.

Amiidae (bowfin; class Osteichthyes, subclass Actinopterygii, order Amiiformes) A fairly large (up to 6 kg) fish, *Amia calva*, is the only living representative of its family. It is characterized by a long dorsal fin with only soft rays, a gular plate, a heterocercal tail, and lung-like airbladder. It is a carnivorous species, in which the male guards the nest and the larvae.

Amiiformes (class Osteichthyes, subclass Actinopterygii) Order of fairly primitive bony fish consisting of several families dating back to the Triassic Period, and considered by some to be intermediate between the Chondrostei and the Teleostei. Until recently they were grouped with the order Semionotiformes in the infraclass Holostei.

amine Organic base derived from ammonia by the replacement of one or more of the hydrogens by organic radical groups. The resultant amine is designated primary, secondary, or tertiary according to the number of hydrogens replaced.

amino acid Organic compound containing an acidic carboxyl (COOH) group and a basic amino (NH_2) group. They constitute the basic building blocks of peptides and proteins and are classified either (a) as neutral, basic, or acidic, or (b) as non-polar, polar, or charged.

amino-acid sequence The sequence of amino acid residues in a polypeptide chain that represents the primary structure of a protein. This sequence is unique to each protein and influences the protein's secondary, tertiary, and quaternary structures.

amino group The radical group NH_2.

aminopeptidase Enzyme that catalyses the hydrolysis of amino acids in a polypeptide chain by acting on the peptide bond adjacent to the essential free amino group.

amino sugar Monosaccharide in which an amino group has been substituted for one or more hydroxyl groups.

aminotransferase *See* transaminase.

Ammobates *See* Anthophoridae.

ammocoete Larva of the lamprey (family Petromyzonidae). After hatching the ammocoete lives buried in mud for several years. It then undergoes metamorphosis, transforming it into an adult lamprey.

Ammodytidae (sand-lance, sand-eel; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of fish with elongated bodies and long dorsal fins. The pelvic fins are often absent, as in *Ammodytes tobianus* (sand-eel) of W. Europe, which is caught in considerable quantity for consumption as well as bait. Feeding on animal plankton, the sand-eels themselves form an important part of the diet of cod, salmon, etc. There are about 12 species, found in marine coastal waters.

ammonites *See* Ammonoidea.

ammonium fixation The adsorption of ammonium ions (NH_4^+) into inter-layer sites of the clay minerals, similar to locations of potassium in hydrous mica, which renders them unavailable to plants.

Ammonoidea (phylum Mollusca, class Cephalopoda) Subclass of cephalopods which generally have planispirally coiled, septate shells. Characteristically the shells are tightly coiled and planispiral, although some are coiled loosely or spirally; the protoconch is globular; the shells may be either involute or evolute. Some forms have marked ventral keels; ribs and nodes may also be present. The siphuncle is variable but mainly ventral in position. Sutures are often very complex. Cameral deposits are absent. The Ammonoidea were probably tetrabranchiate cephalopods. They constitute the largest cephalopod subclass, with 163 families including the ammonites, in which the suture lines form very complex patterns; the ceratites, in which part of the suture line is frilled; and the goniatites, with relatively simple suture lines. They range in age from Devonian to Upper Cretaceous. All members are now extinct.

ammonoids *See* Ammonoidea.

ammonotelic Applied to organisms (e.g. many aquatic invertebrates and teleost fish) that excrete nitrogenous waste derived from amino-acid catabolism in the form of ammonia.

Ammophila *See* Sphecidae.

amnion Inner cellular layer (epithelium) surrounding the fluid-filled embryo sac of reptiles, birds, and mammals. The wall of this sac has two layers of epithelium, with mesoderm and coelomic space between. The outer layer is usually called the chorion. The amnion and chorion develop as folds in the ectoderm and mesoderm which grow up around the sides of the embryo, eventually covering it. The amniotic fluid within the sac provides a liquid environment for the embryo, necessary for animals that reproduce on land. It may also cushion the mammalian embryo against distortion by maternal organs pressing on it. Sometimes the term 'amnion' is applied to the entire embryo sac.

amniote Applied to a type of development typical of higher vertebrates (reptiles, birds, and mammals), in which the amnion (a protective membrane) surrounds the embryo in a bag of ('amniotic') fluid. The amnion is primitively associated

with a shell, and is capable of gaseous exchange; its development thus enabled eggs to be laid on dry land for the first time in vertebrate evolution.

amniotic fluid *See* amnion.

amoeba (ameba) Any eukaryotic single-celled organism that is naked and that changes shape due to the irregular extension and retraction of pseudopodia.

amoebiasis Any disease in which the causal agent is an amoeba. The most common form of amoebiasis is amoebic dysentery, caused by *Entamoeba histolytica*. This disease varies in severity from mild diarrhoea to severe or fatal dysentery.

amoebic dysentery *See Entamoeba*; and amoebiasis.

Amoebida (class Rhizopodea) Order of protozoa in which each cell contains a single nucleus and is of indeterminate shape. The cells form lobopodia which serve for locomotion and feeding. Most species are free-living in freshwater, moist-soil, or marine environments; a few are parasitic. There are several families, and many genera, one of which is the genus *Amoeba*. *A. proteus*, a popular subject for study in elementary biology courses, measures up to about 0.6 mm across, and is found in slow-moving or still freshwater habitats.

Amomum (family Zingiberaceae) Genus of 150 species of Old World tropical rhizomatous, aromatic herbs, with flowers usually borne on leafless scapes.

Amoora *See Aglaia*.

Amorphophallus (family Araceae) Genus of herbs and shrubs producing a corm-like rhizome, cultivated for food in some species. The plants bear few leaves, which are several times palmate, on a long erect stalk; and are sometimes huge, up to several metres across. The inflorescence is sometimes massive (1 m tall in *A. titanium*); the spathe blotched purple; and has a powerful, foetid odour. There are 100 species, native to Africa and Asia.

Amorphoscelidae (order Mantodea) The smaller of the two families of mantids, comprising insects which are small and mottled in colour, and which have raptorial forelegs devoid of spines on their external, lower sides. Many species have wingless females. Most live on rough-barked tree trunks against which they are well camouflaged. The pronotum tends to be shorter than that of members of the Mantidae. Most of the 50 or so amorphoscelid species are found in Australia.

amorphous Applied to materials that have no regular atomic structure, or in which no extensive portions have a regular structure; but small units, irregularly aligned or stacked, may have a regular structure.

amorphous cloud Continuous cover of low, featureless cloud (e.g. nimbostratus), often producing rain.

amorphous material Material without internal structure.

amphetamine 1-phenyl-2-aminopropane, a drug that stimulates the central nervous system and prevents sleep.

amphi-Atlantic species Plants that are found on both sides of the N. Atlantic, along the seaboards of eastern North America and Europe. This disjunct distribution pattern is thought to be largely inherited from a single circum-North-Atlantic coastal-plain flora. Typical representatives are *Carex paleacea* (a sedge) and *Ligusticum scoticum* (Scotch lovage).

Amphibia (amphibians) Class represented today by just three groups, of which the Urodela (salamanders) and Anura (frogs and toads) are the best known. The class was much more varied formerly, and in the Triassic some forms, e.g. *Mastodontosaurus*, grew up to 6 m long. Amphibians appeared first in the Devonian, having evolved from rhipidistian (lobe-finned) fish. They flourished in the Carboniferous and Permian but declined thereafter. The first modern types were established during the Triassic. They are poikilothermic vertebrates; the majority terrestrial, but developing by a larval phase (tadpole) in water. The skin is soft, naked (non-scaly), rich in mucous and poison glands, and important in cutaneous respiration. There are about 3000 extant species. Most are found in damp environments and they occur on all continents except Antarctica.

amphibians *See* Amphibia.

amphibiotic 1 Applied to an organism that can be either parasitic on or symbiotic with a particular host organism. 2 Living in water (larval form) and later on land (adult form).

amphiblastula A poriferan (sponge) larva in which the area of flagellate cells is equal to the area of non-flagellate cells. At metamorphosis the flagellated cells move to the interior and become choanocytes.

amphiboles Group of minerals that have double silicate, anionic chains or ribbons in the form Si_4O_{11}, joined to a variety of metals including calcium, magnesium, iron, sodium, and aluminium. The specific gravity is usually around 3.0, and the hardness near 6.0. The basic, simple amphibole is orthorhombic in crystal system, but the bulk of the amphiboles (which includes tremolite, actinolite, hornblende, and glaucophane) crystallize in the monoclinic system. These are widely spread rock-forming minerals found in many types of igneous and metamorphic rock.

Amphibolurus barbatus (bearded lizard, bearded dragon, Jew lizard; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Sturdy, long-tailed agamid, up to 60 cm long: it has a spiny body with a pouched jaw, which when extended in display resembles a beard, which is larger in males. It lives in the scrub and desert of Australia.

amphicoelous vertebrae Condition in which the central part of each vertebra (the centrum) is concave on both anterior and posterior faces. *See* Leiopelmatidae.

amphidetic Applied to a pelecypod ligament located in the anterior and posterior areas, around the beaks.

amphidisc One of the small flesh spicules of poriferans (sponges), if the spicule has recurved rays at the end of the rod.

Amphidiscophora (phylum Porifera, class Hexactinellida) Subclass of sponges in which the small, flesh spicules occur as amphidiscs.

amphidromic point The centre of an amphidromic or tidal system; a no-tide or nodal point around which the crest of a standing wave or a high-water level rotates once in each tidal cycle. The tidal range increases progressively with increasing distance from the central point. In the northern hemisphere the high water rotates anticlockwise around the central point.

amphidromous Applied to the migratory behaviour of fish moving from fresh water to the sea, and vice versa. Such migration is not for breeding purposes, but occurs regularly at some stage of the life cycle (feeding, overwintering, etc.).

Amphineura (phylum Mollusca) Class of elongate, bilaterally symmetrical, marine molluscs in which the shell, if present, consists of seven or eight overlapping, calcareous plates on the dorsal surface. The head is poorly differentiated, if at all. Some possess an effective radula. The posterior mantle cavity contains the anus and gills. A broad, flat foot occurs ventrally and is used for creeping. The anatomy is typically molluscan, with a primitive, ganglionic nervous system. All are blind, and lack tentacles. Sexes are generally separate. The class first appeared in the Upper Cambrian.

amphineustic Applied to insect larvae in which the spiracular openings of the respiratory system are restricted to a pair each on the prothorax and the posterior of the abdomen. The condition is common in larval Diptera.

Amphipnoidae (cuchia; class Osteichthyes, subclass Actinopterygii, order Synbranchiformes) Family of fish that includes only one species, *Amphipnous* (*Monopterus*) *cuchia*, of S. Asia. It is of interest because it has two lung-like air sacs connected with its gill chambers.

Amphipoda (sandhoppers, beach-hoppers, beach fleas, water lice; class Crustacea) Order of mainly laterally compressed crustaceans, with the cephalothorax devoid of a carapace and the whole head fused to one thoracic segment, or occasionally to two. The first three pleopods are usually many-segmented swimmerets, the posterior ones modified for jumping and comprising a few segments. The gills are borne on the thoracopods. There are 4000 species, including such familiar forms as *Talitrus* (beach-hoppers) of the upper tide line, and *Gammarus* (water 'lice') of mainly fresh or brackish water. The dorsoventrally compressed *Cyamus* (whale lice) are host-specific parasites of whales.

Amphisbaenidae (worm lizards; order Squamata, suborder Sauria (Lacertilia)) Family of subterranean lizards, with a small wedge-shaped head, adapted for digging. The body is cylindrical, with loose skin, and rings of scales. The tail is short. Worm lizards are generally limbless, but forelimbs are present in *Bipes*. Eyes and ears lie beneath the skin. There are about 130 species, found in America, the Mediterranean region, and Africa.

Amphiterygidae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies that resemble the Anisoptera (true dragonflies) in their habit of resting with their wings open. They are distinguishable from all other zygopteran families by having five or more antenodal cross veins, of which the first two are thickened and the rest are incomplete. The robust larvae are adapted for clinging to rocks in fast-flowing streams, and have huge, saccoid-shaped, caudal gills. The family is mainly tropical, and 19 extant species have been described.

amphitrophic Applied to an organism that can carry out photosynthesis in the presence of light and that can also grow chemotrophically in the dark.

amphitropical species Species having disjunct distribution patterns, one part of the range being to the north of the equator, the other to the south, and geographically quite separate. These disjunctions probably arose in the Pleistocene when the climatic belts were contracted, and migration across the equator would have been easier.

Amphiumidae (Congo eels, lamper eels; order Urodela (Caudata), class Amphibia) Family of eel-like, semi-larval salamanders with a cylindrical body up to 1 m long, rudimentary limbs and lungs, small lidless eyes, no tongue, and external gills that are lost in adults. They are nocturnal feeders on insects, molluscs, crustaceans, etc. They may leave the water in wet weather. Eggs are laid in a nest. Fertilization is external, with no spermatophore. There is a single genus, *Amphiuma*, and three species, occurring in freshwater swamps in the south-eastern USA.

Amphycyonidae Family of very large, heavily built dogs, which appeared during the Oligocene, spread to all the northern continents, and became extinct in the Pliocene. They have been called 'dog-bears', but apart from their size they had few truly bear-like features.

Amphymerycidae Family of primitive ruminants from the late Eocene and early Oligocene of the Old World. Some authorities believe these small animals were in the direct line of descent to the advanced ruminants.

amplexicaul *See* stipule.

ampoule Sealed glass container, used to contain a measured quantity of a volatile compound, or a solution of measured concentration.

Ampulicidae (cockroach wasps, digger wasps; order Hymenoptera, superfamily Sphecoidea) The most primitive family of sphecid hunting wasps, in which the antennae are inserted low on the face, with the sockets touching or close to the fronto-clypeal suture. The pronotum has a high collar, and

is long to very long and often tuberculate The propodeum is long to very long, with the enclosed area entirely dorsal, and U-shaped to nearly triangular. The mid-tibiae have two apical spurs, and the claws have an inner tooth. The marginal cell of the forewing is acuminate apically, and apendiculate. The forewing has two or three submarginal cells, and two recurrent veins, (the first recurrent received by submarginal 1 or 2, the second received by 2 or 3). The abdomen is sessile, or with a petiole composed of the sternum and tergum. The male genitalia have a movable digitus and cuspis. There are about 160 species, mainly tropical, and the females provide their nests with stung and paralysed cockroaches. *See* hunting wasp.

ampullae of Lorenzini Jelly-filled tubes located in the heads of sharks. Open at the surface, the deeper parts of the ampullae contain sensory cells sensitive to electrical gradients such as those produced by potential prey hidden in a sandy sea-bottom.

ampulliform Flask-shaped or bottle-shaped.

Amyema (family Loranthaceae) Genus of plants of the mistletoe family which are stem hemi-parasites, usually with red or yellow flowers, and seeds spread by birds. They are found in SE Asia, the Pacific, and (32 species) in Australia.

amygdale Spheroidal, ellipsoidal, or literally 'almond-shaped' cavity or vesicle within a lava, often filled with secondary minerals, e.g. calcite, quartz, or zeolites. A lava with empty amygdales is termed 'scoriaceous'.

amygdaliform Almond-shaped.

Amygdalus (almond, peach; family Rosaceae) Genus of a few species, apparently from temperate Asia, but almond, peach, apricot, and nectarine have long been cultivated and are grown in many parts of the world. They are close to *Prunus*, but have axillary buds in threes, and fruits that are usually downy, with the stone pitted or wrinkled.

amylase Member of a group of enzymes that hydrolyse starch or glycogen by the splitting of glucosidic bonds, so giving rise to the sugars glucose, dextrin, or maltose. They are widely distributed in plants and animals, occurring in micro-organisms and, for example, in pancreatic juices and salivary glands.

amylolytic Capable of digesting starch.

amylopectin Branched-chain polysaccharide that is found in native starches composed of glucose units joined by alpha-1,4 glycosidic bonds and at points of branching by alpha-1,6 bonds.

amyloplast Plastid that synthesizes and stores starch, to the exclusion of other activities.

amylose Long, unbranched-chain polysaccharide component of native starch composed of glucose units joined by alpha-1,4 glycosidic bonds.

Amynodontidae (order Perissodactyla, suborder Ceratomorpha, superfamily Rhinocerotoidea) One of two extinct families of rhinoceros-like animals, which lived during the Eocene and Oligocene in America and Eurasia, and which persisted into the Miocene in Asia. They were analogous in size and shape to the hippopotamuses and, like them, probably lived in rivers.

amynodonts *See* Amynodontidae.

Anabaena (order Nostocales) Genus of filamentous cyanobacteria in which the filaments when viewed under the microscope resemble strings of beads. Thick-walled, clear heterocysts can be seen at intervals along the filaments. Akinetes are formed. Species are capable of fixing atmospheric nitrogen. They are common in aquatic environments, where they are planktonic, buoyed up by gas vacuoles. *A. azollae* lives in symbiotic association with the small floating fern, *Azolla*.

Anabantidae (climbing gouramis, labyrinthfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of fish capable of aerial respiration because of the presence of a supra-branchial organ or an auxiliary breathing apparatus. There are about 40 species, the best known of which is *Anabas testudineus* (climbing gourami or walking fish) of S. Asia. It lives in freshwater ponds and swamps, but can crawl over land in search of a new source of water during the dry season. The colourful gouramis, popular aquarium fish, are now placed in the family Belontiidae. *See also* accessory respiratory organs; and air breathing in fish.

Anabas testudineus (climbing gourami, climbing perch) *See* air breathing in fish; and Anabantidae.

anabatic wind *See* katabatic wind.

Anablepidae (four-eyed fish; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of fish that includes the species *Anableps anableps*, unusual because its bulbous eyes are actually divided into upper and lower lobes so that the two eyes actually function as four eyes. It is a predominantly freshwater fish from C. America.

anabolism That part of cellular metabolism that encompasses those reactions that require energy and that result in the biosynthesis of needed compounds.

Anacanthini Older name for the cod-like fish species now included in the order Gadiformes.

Anacardiaceae Family of resinous trees, shrubs, and climbers, in which the leaves are alternate, mostly pinnate, and exstipulate. The flowers are regular, and mostly bisexual; they have five fused sepals; five free petals; 5–10 stamens; a disc; and a superior ovary, which is one- to five-locular, each locule having a pendulous ovule. The fruit is usually a drupe. There are about 77 genera, with about 600 species, which are found throughout the tropics; and a few northern outliers.

Anacardium (family Anacardiaceae) Genus of trees, with simple leaves. The fruit is a kidney-shaped nut with a resinous, irritant pericarp, surmounting a swollen, fleshy, edible peduncle. *A. occidentale* (cashew nut) is a bushy tree, extensively cultivated. There are 15 species, of neotropical distribution.

anachoresis In animals, the habit of living in holes or crevices as a means of avoiding predators.

anaconda *See Eunectes murinus*.

Anacystis (order Chroococcales) Genus of cyanobacteria; freshwater forms consist of free-floating masses of spherical cells, while terrestrial forms may be single-celled or colonial.

anadromous Applied to the migratory behaviour of fish that spend most of their lives in sea, but that then migrate to fresh water to spawn (e.g. salmon and lamprey).

anaerobe Organism that can grow only in the absence of oxygen.

anaerobic 1 Of an environment: one in which air (oxygen) is absent. 2 Of an organism: one able to grow only in the absence of oxygen, i.e. an anaerobe. 3 Of a process: one that can occur only in the absence of oxygen.

anafront Front (warm or cold) at which upward movement of the warm-sector air is active, commonly producing clouds and precipitation.

anagenesis In the original sense, refers to evolutionary advance. Now it is often applied more widely, to virtually all sorts of evolutionary change, along a single, unbranching lineage.

analcime Mineral, specific gravity 2.2–2.3, hardness 5.0–5.5, and with the chemical composition $Na(AlSi_2O_6).H_2O$. It occurs in rocks of low-temperature igneous origin that are rich in soda and water (e.g. nephaline syenites), and also volcanic tuffs. It can be colourless or white, with grey, red, and greenish tints, and is sometimes pigmented with iron oxides. It has a vitreous lustre. It crystallizes in the cubic system. The crystals are polyhedra and tetragonal-trioctahedra, and are also found in granular aggregates.

anal fin Unpaired fin located on the ventral side of the body of a fish, posterior to the anus. It plays an important role in the swimming movements of sharks and bony fish.

analogous variation Features with similar functions which have developed independently in unrelated taxonomic groups, in response to a similar way of life, or similar method of locomotion, or similar food source, etc. Thus the wings of birds and insects are analogous.

anamniote Applied to a type of development typical of lower vertebrates (fish and amphibians). The egg lacks a shell and protective embryonic membranes: consequently it must be laid in water or in a suitably damp environment.

anamorphic growth *See* anamorphosis.

anamorphosis (anamorphic growth) Developmental phenomenon in some Protura and Chilopoda (centipedes), e.g. *Lithobius*, *Bothropolys*, and *Scutigera*: the young do not possess the full, adult complement of body segments and legs on hatching; these are developed successively in later stages, after moulting. Centipedes that hatch with only part of the adult complement of segments take several years to reach sexual maturity. *Compare* epimorphosis.

Ananas (family Bromeliaceae) Genus of plants in which the stem is short and leafy, trapping water in the overlapping leaf bases. Inflorescences are terminal, forming a compound structure in the fruit beyond which there develops a tuft of leaves. The pineapple is *A. comosus*. There are five species of terrestrial, tropical American habitats.

anaphase Stage of mitosis or meiosis at which the centromere becomes functionally double, and daughter chromosomes separate from the equator, moving towards the opposite poles of the spindle. The spindle then elongates and pushes the two groups of chromosomes further apart.

Anaplasmataceae (order Rickettsiales) Family of bacteria in which the cells are very small and obligately parasitic in the blood of vertebrates. They are transmitted from one host to another by arthropod vectors, e.g. ticks. Some can cause disease. There are several genera.

Anapsida Group of reptiles characterized by a skull that lacks apertures in the temple regions behind the eyes. The only living representatives are the turtles (Chelonia) but three other groups flourished in the late Palaeozoic, two of them surviving into the Triassic.

Anaptomorphidae (order Primates, suborder Prosimii, infraorder Tarsiiformes) Extinct family of tarsier-like animals showing signs of tarsioid specialization. The brain was similar to that of a modern tarsier but the olfactory regions were more highly developed, and the temporal and occipital lobes enlarged. The eyes were large, the face short. There were at least 20 genera, distributed in Europe and America from the Palaeocene to Oligocene.

Anarhichadidae (wolffish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which are eel-like in shape, have a very long dorsal fin, lack pelvic fins, but have powerful jaws with strong teeth used to crush hard-shelled molluscs and crustaceans. The common wolffish, *Anarhichas lupus*, is frequently caught in trawls and marketed fresh or as frozen fillets. There are about six species, living in cold to Arctic waters.

Anas (dabbling ducks; family Anatidae) Genus of mainly freshwater, short-legged, narrow-winged ducks, with typically flattened bills. Almost all have a speculum. They feed mainly by dabbling or up-ending on vegetable matter and invertebrates. There are 36 species, with cosmopolitan distribution, most species being migratory. They are typified by *A. platyrhynchos* (mallard) which is the ancestor of most domestic ducks.

Anasca (class Gymnolaemata, order Cheilostomata) Suborder of relatively primitive cheilostome bryozoans in which the tentacles are extruded by a simple hydrostatic system without a compensation sac (*see* Ascophora). They occur from the Jurassic to Recent.

Anaspidea (Aplysiacea, Aplysiomorpha; phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods which have an internal and much reduced shell. Only a small mantle cavity is present. The order contains the sea-hares.

Anaspidiformes (class Cephalaspidomorphi) Extinct order of fossil fish-like vertebrates considered to be related to the lampreys. They had a fusiform body with a hypocercal tail, and up to 15 pairs of external gill openings. Extant during the Silurian and Devonian Periods, these small (up to 15 cm in length) animals lived predominantly in fresh water.

Anas platyrhynchos (mallard) *See Anas*.

anastomosis In woody plants, the linking of branches.

anatase (octahedrite) Mineral, specific gravity 3.9, hardness 5.5–6.0, chemical composition TiO_2. It occurs as an accessory mineral in metamorphic and igneous rocks, and is also found in hydrothermal veins and granite pegmatites. Its most distinguishing feature is its octahedral shape. In colour it may be yellow, shades of brown, blue, or black, with a white streak, and it has a vitreous lustre. It crystallizes in the tetragonal system. The crystals are normally bipyramidal octahedra, but the mineral can also be tabular in shape.

Anatidae (ducks, geese, swans; order Anseriformes) Family of mainly aquatic birds with flat, lamellate bills (except *Mergus*). The front toes are webbed. Many Anatidae are sexually dimorphic. They have thick feathers with insulating down. The flight feathers are moulted simultaneously after breeding. They feed on vegetable and animal foods. They nest on the ground or in holes in trees, among rocks, or in the earth, and the nest is usually lined with down. There are 143 species, with cosmopolitan distribution. *See also* carpal spur; and primaries.

Anatolepis heintzi Possibly one of the earliest jawless fish, known from a number of associated scales and fragments discovered in Lower Ordovician (Arenig) strata of Spitzbergen.

Anax imperator (emperor dragonfly; order Odonata, family Aeshnidae) One of the largest dragonflies occurring in Eurasia. The thorax is pale jade-green; the abdomen in males is mainly blue, with fine, black markings—in females the blue is replaced with olive-green. The females hawk high in the air in woodland areas and return to ponds or lakes only to mate and lay eggs. The males rarely leave the vicinity of water, and remain on the wing for long periods.

Ancalomicrobium Genus of Gram-negative bacteria not assigned to any taxonomic family. The cells are variable in shape, according to conditions, but typically have 2–8 stalk-like extensions. Reproduction is by budding from one site on the cell body (not from stalks). These bacteria can grow under aerobic or anaerobic conditions, and are chemo-organotrophs. They are found in aquatic environments.

anchovy (*Engraulis encrasicolus*) *See* Engraulidae.

Anchusa (alkanets, etc.; family Boraginaceae) Genus of usually bristly herbs with flowers that are blue or purple, pentamerous, with scales closing the throat of the corolla-tube, and oblong leaves. Several species are cultivated for their flowers. There are about 30 species, found in Europe and Asia.

ancient countryside In Britain, an area in which most of the fields, woods, roads, etc. were present before 1700.

ancient woodland Both primary and secondary woodland that originated prior to a particular date, which in Britain is often set at around 1600, as secondary woodland was rarely created by planting before then.

Ancistrocladaceae Family of mostly woody climbers, with twig tips modified to form coiled hooks. The leaves are simple and alternate, with stipules absent or soon caducous. Flowers are cymose, regular, and bisexual. They have five fused sepals and petals, the former enlarging in the fruit (a nut); 10 (or occasionally five) stamens; the ovary semi-inferior, with a single basal ovule; and three connate styles. There is one genus, containing about 10 species, with a disjunct distribution in W. Africa and SE Asia.

Ancylopoda (Chalicotheres; superorder Mesaxonia, order Perissodactyla) Extinct suborder of horse-like animals, some with forelimbs longer than hind limbs, distributed widely in the Holarctic from the Eocene to Pleistocene. They differed from contemporary perissodactyls in possessing three toes whose terminal phalanges were cleft, and undoubtedly bore claws rather than hoofs. Probably they fed on roots and tubers and the claws and long forelimbs were used in digging.

andalusite Mineral, specific gravity 3.2, hardness 6.5–7.5, and with the chemical composition Al_2SiO_5, whose name is derived from the Andalusia area of Spain. It occurs principally in thermally metamorphosed rocks, and low-grade, regionally metamorphosed rocks. It can also occur in pegmatites with corundum, tourmaline, topaz, and other minerals. Transparent varieties are used as gemstones. The mineral is distinguished by its square form, hardness, and occurrence in metamorphic rocks that show alteration to aggregates of white mica. Its colour can be pink or red, but it can also be grey-brown and green, with a vitreous lustre. The crystal system is orthorhombic. The crystals are prismatic with a pseudo-tetragonal form which has a characteristic cross-section, and the mineral can also be massive. *See also* aluminosilicates.

Andean condor (*Vultur gryphus*) *See Vultur*.

Andean floral region Part of Good's (1974) Neotropical kingdom. The region is elongated and extends from Colombia to S. Chile, spanning both tropical and temperate climates, but it also includes the Galápagos Islands. The Galápagos Islands are included as although they have numerous endemic species they have only two important endemic genera: *Leiocarpus* and *Scalesia*. The mainland flora is rich in endemic genera, however, and has supplied many economic and garden plants.

andesine Member of the plagioclase group of feldspar minerals, with specific gravity 2.64, hardness 6.0–6.5, and chemical composition

$20Na(AlSi_3O_8)30Ca(Al_2Si_2O_8)$. It occurs extensively in igneous rocks, especially diorites, granites, and quartz porphyries, and also in pegmatites. Its colour is normally greyish-white, greenish, bluish, or with a greenish and reddish hue, and it has a vitreous lustre. It crystallizes in the triclinic system. Crystals are normally prismatic, and tabular, but these are rare and irregular grains are much more common. It is an important rock-forming mineral.

andesite Fine-grained volcanic rock characterized by the presence of plagioclase feldspars of the oligoclase–andesine end of the range, and of some combination of augite, orthopyroxene, and hornblende. In chemical and mineralogical terms andesites are similar to diorites. The feldspars frequently occur as strongly zoned phenocrysts. Glassy andesites are rare. An increase in the quartz percentage marks the gradation of andesites into diorites. An increase in the percentages of alkali feldspars marks the change from andesites into trachyandesites, some of which (e.g. mugearite and hawaiite) exhibit basaltic features, including a higher olivine content.

andhis Local term, used in the north-west of the Indian subcontinent, for dust storms accompanying violent squalls, caused by strong convection.

Andira (family Leguminosae, subfamily Papilionatae) Genus of trees some with useful timber. The fruit is globose, woody, and dehiscent. *A. inermis* (angelin) is widely planted as an ornamental. There are 35 species, occurring in tropical Africa and America.

andiroba *See Carapa.*

andradite Member of the garnet group of minerals, specific gravity 3.75, hardness 6.5–7.5, chemical composition $Ca_3Fe_2(SiO_4)_3$, and named after the Portuguese mineralogist who first described it. It occurs widely in metamorphic and igneous rocks, and also in beach sands and alluvial placers. Its colour is yellow, greenish, or brownish-red, to black; and it has a greasy to vitreous lustre. It crystallizes in the cubic system, the most common form of the crystals being rhombododecahedra. Fine crystals are used as gemstones, and the mineral can be used as an abrasive.

Andreaeidae (class Musci) Subclass of acrocarpous mosses with several unique characteristics; they are sometimes included in a separate class (Andreaeopsida). The plants are small and characteristically black or dark brown. The protonema is thalloid. The capsules differ from those of other mosses in that they open by (usually four) longitudinal slits. There is one family, with two genera. They form scattered patches on rocks in mountainous and arctic regions.

Andrena fulva (tawny mining bee; order Hymenoptera, family Andrenidae) One of the commonest and most conspicuous of the solitary mining bees that appear in April in Europe, including Britain. The females are clothed in a dense coat of bright, fox-red hairs. Although strictly solitary, they often nest in dense aggregations in well-drained soils, especially in lawns in town gardens. Brood cells are excavated one at a time at the end of lateral branches from the main, vertical burrow. The females forage at a wide range of spring flowers. The males are more slender than the females, and are drab brown with a tuft of silvery hairs on the face below the antennae. There is a single generation each year, and new adults overwinter in their natal cells until the following spring.

Andrenidae (solitary mining bees; order Hymenoptera) Large family of short-tongued, solitary bees. Each antennal socket is connected to the clypeus by two sutures. The tongue is pointed. The segments of the labial palps are similar, or sometimes the first or second is elongate and flattened. The coxae of the mid-leg are externally shorter than the distance from their apices to the posterior wing bases. The pollen scopa is a dense fringe of hind tibial, branched hairs, often augmented by a coxal floccus of long, curved hairs. The brood cells are lined with a wax-like secretion of the Dufour's gland.

Andrias japonicus (Japanese giant salamander; order Urodela (Caudata), family Cryptobranchidae) Largest living amphibian: up to 150 cm long; 11 kg in weight. It inhabits fast-flowing water. Surface-living larvae metamorphose in their third year into flattened, gill-less bottom-dwellers. Individuals are known to have lived for 50 years. It feeds nocturnally on fish, other amphibians, insects, etc.

Andricus kollari *See* oak marble gall.

androchronial scale *See* androconial scale.

androconial scale (androchronial scale) In male Lepidoptera, a wing or body scale that is modified for the dispersal of a sexual scent (pheromone). Glandular cells in the wing membrane or integument of the body connect with the base of the scale, but just how the scent is dispersed is not fully understood. The scent may diffuse via the hollow body of the scale to the fimbriae, or minute hairs, at the scale tip; or it may simply pass on to the surface of the scale. Androconia may be scattered singly over the surface of the wing, but are sometimes grouped together in tufts.

androecious Applied to a plant that possesses only male flowers.

androecium Collection of stamens that form the male reproductive organs of a flowering plant. These may be borne together with the female reproductive organs (the gynoecium, comprising stigma, style, and ovary) within the same flower of an individual plant, in which case the plant is referred to as hermaphrodite; or they may be borne on the same individual but in different flowers, in which case the plant is termed monoecious; or they may be borne separately on different individuals, in which case the plant is termed dioecious.

androgens Generic term for the hormones, secreted principally by the testis, that regulate the development of secondary sexual characteristics. (It is interesting to note that androgens have been isolated from ovarian tissues.)

anemochoric Dispersed by wind.

anemometer Instrument for measuring wind speed, usually either from the rotation of a wind-driven turbine ('rotating-cups anemometer'), or from the wind pressure through a tube aligned by a vane to point into the wind ('pressure-tube anemometer').

Anemone (family Ranunculaceae) Genus of poisonous, perennial herbs (or, rarely, low shrubs): they have rhizomes; palmate, lobed leaves, some of which are radical, the stem leaves occurring in a whorl of three some way below the flowers; and solitary flowers (or occasionally two or three together). They have a perianth of one whorl, which is petal-like, and many free stamens and carpels. The fruit is a head of unplumed achenes. There are about 100 species, found mostly in northern temperate regions.

anemonefish *See* Pomacentridae.

anemophilous Pollinated by wind.

anemophily Pollination of plants by wind.

aneroid barometer Instrument for measuring atmospheric pressure as represented by the height (or thickness) of a sealed, flexible, metal, concertina-shaped drum from which air has been partially evacuated. Variations in the height of the drum are transmitted to a pressure scale either mechanically, through a series of levers and a pointer, or electronically.

aneucentric Applied to an aberrant chromosome possessing more than one centromere.

aneuploid Cell or organism whose nuclei possess a chromosome number that is greater by a small number than the normal chromosome number for that species. Instead of having an exact multiple of the haploid number of chromosomes, one or more chromosomes are represented more times than the rest.

Angaraland Name given by the Austrian geologist Eduard Suess (1831–1914) to a small shield in north central Siberia, where Precambrian rocks are exposed, and which was considered to be the nucleus for subsequently developed structural features in Asia.

angelfish *See* Chaetodontidae; and Cichlidae.

Angelica (family Umbelliferae) Genus of tall perennial herbs with stout, hollow stems. They have two or three leaves, which are pinnate with broad oval leaflets. The umbels are compound, with many rays, few bracts, but many bracteoles. The fruits are ovoid, and flattened dorsally, with two broad, marginal rays, and three dorsal ridges on each carpel. *A. archangelica* is cultivated and candied as a sweetmeat. There are some 70 species, occurring in the northern hemisphere, and in New Zealand.

angelshark *See* Squatinidae.

angiocarpy Type of development of a fungal fruit body in which the spore-bearing tissue is enclosed for part of the period.

Angiosanthos (*Angiozanthos*; kangaroo paws; family Haemodoraceae, tribe Conostyleae) Genus of herbs with unusually shaped spikes, and racemes of tubular, woolly flowers which may be orange, red, or green. They are now widely cultivated, and species hybrids are developed for increased vigour, greater flower numbers, and different colours. *A. manglesii* (red-and-green kangaroo paw) is the state emblem of W. Australia. There are ten species, endemic to Australia, where they are found wild in soils of low fertility in the south-west.

Angiosanthos manglesii (red-and-green kangaroo paw) *See Angiosanthos*.

Angiospermae (angiosperms) Flowering plants, one of the two divisions of the Spermatophyta (seed plants), the other being the Gymnospermae, from which they are distinguished by producing seeds that are enclosed fully by fruits. They are the most highly evolved of plants, and appear first in rocks of Lower Cretaceous age.

Angiozanthos *See Angiosanthos*.

angle of repose Maximum angle at which unconsolidated material can stand. Various factors determine this angle, including particle size and angularity, the degree of interlocking between particles, and pore-water pressure. A typical angle of repose for coarse scree is 32–36°.

anglerfish 1 *See* Lophiidae; and Melanocetidae. 2 (frogfish) *See* Antennariidae.

anglesite Secondary lead mineral, specific gravity 6.3, hardness 3, chemical composition $PbSO_4$. It normally occurs in the oxidized zone of lead deposits, and often surrounds a core of galena. It is distinguished by a high specific gravity and by its association with galena. It is normally colourless to white, but sometimes it can be yellow, grey, or coloured by a bluish tinge; it has an adamantine lustre, and a white streak. It crystallizes in the orthorhombic system. The crystals can be tabular, prismatic, or pyramidal, and it occurs as massive, granular, or compact aggregations.

Anglocetus beatsoni Fossil originally described in 1964 by Tarlo as the first archaeocete whale. It is now recognized to be no more than the erroneous description of the remains of the leathery turtle *Eosphargis gigas*.

Angophora (family Myrtaceae, subfamily Leptospermoideae) Genus of trees and shrubs which are closely allied to eucalypts, but which have flower petals and no operculum, and opposite leaves. They are found in or near rain forests in the east. *A. costata* (Sydney red gum or smooth-barked apple) is a tree growing to at least 14 m, with red bark and white flowers in spring and summer. It is the dominant tree of deep sands behind coastal dunes in New South Wales, and on alluvial sands. There are eight species, all endemic to Australia.

Angophora costata (Sydney red gum, smooth-barked apple) *See Angophora*.

angsana Timber from *Pterocarpus indica*. *See Pterocarpus*.

Anguidae (lateral-fold lizards, slow worms, glass snakes; order Squamata, suborder Sauria (Lacertilia)) Family of reptiles whose members vary from

four-legged lizards to legless snake-like forms. All have a forked tongue (unlike skinks of similar form), mobile eyelids, and tail autotomy. There are about 40 species, from America, Europe, Asia, and N. Africa. *See also Anguis fragilis*; and *Ophiosaurus apodus*.

Anguillaria (family Liliaceae) Genus of small, bulbous plants found in wet, southern eucalyptus forests. There are three species, endemic to Australia, but close relatives occur in southern Africa.

Anguillidae (eels; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Family of snake-like fish with long, cylindrical bodies, narrow vertical gill slits, and a long dorsal fin continuing through the tail fin into the anal fin. The skin bears minute scales. Widely distributed in tropical and temperate regions, the adults tend to live in fresh water for a number of years, finally migrating to the sea to spawn. Being a valuable food fish, eels are marketed in large numbers in many countries. The common eel, *Anguilla anguilla*, is known to spawn in the Sargasso Sea, W. Atlantic, with the juveniles, called elvers, taking up to three years to reach the coast of Europe. There is one genus, *Anguilla*, with about 15 species.

Anguilliformes (class Osteichthyes, subclass Actinopterygii) Order of eel-like fish with elongate, cylindrical bodies, narrow gill apertures, a tail-fin confluent with the low dorsal and anal fins, no ventral fins, and the skin either naked or with minute scales. The order comprises about 22 families, including the Anguillidae (eels), Muraenidae (moray eels), and Congridae (conger eels).

Anguis fragilis (blind worm, slow worm; order Squamata, suborder Sauria (Lacertilia), family Anguidae) Snake-like legless lizard, but one having movable eyelids, and lacking ventral shields. It grows to 54 cm and feeds mainly on slugs and earthworms. It is ovoviviparous. It is a native of Europe (including Great Britain), NW Africa, and W. Asia.

angular Bone, in most Gnathostomata, which forms the angle of the lower jaw. In mammals it forms the tympanic bone.

Anhimidae (screamers; order Anseriformes) Family of black or grey, short-necked, fairly long-legged, ungainly birds. The bill is chicken-like, the toes are long and semi-palmate, the wings broad with a spur on the leading edge. There are subcutaneous air sacs. The ribs lack uncinate processes. These birds are found in marshy habitats where they wade or swim. They are vegetarian and nest on the ground near water. There are two genera, with three species, found in tropical and subtropical S. America.

Anhinga (darters; family Anhingidae) Genus of long-necked birds with an elongated body, long, narrow, pointed bill, and long, stiff tail. They are totipalmate. The food consists mainly of fish, caught under water, and darters often swim with only the head and neck above water. These birds are excellent fliers, and are migratory in some areas. They inhabit the wooded shores of lakes and rivers, breeding colonially in trees. There are four species, often considered to be one, found in all the major continents except Europe.

anhingas *See* Pelecaniformes.

Anhingidae (darters; order Pelecaniformes) Family of one genus, *Anhinga*.

anhydrite Evaporite mineral, specific gravity 2.9–3.0, hardness 3.0–3.5, chemical composition $CaSO_4$, which occurs with gypsum and halite. It is deposited directly from sea water at temperatures in excess of 42 °C, and it can form from the dehydration of gypsum. It also occurs as a 'cap rock' above salt domes, and as a minor gangue mineral in hydrothermal veins. Its distinguishing features are three cleavages at right angles, a density greater than that of calcite, and a hardness greater than that of gypsum. It is normally white to colourless, sometimes with a bluish tinge, but is occasionally grey and reddish; it has a white streak, and a vitreous to pearly lustre. It crystallizes in the orthorhombic system. Crystals are rare, the mineral being usually massive, granular, and fibrous. It is a rock-forming mineral, and is used as a raw material for cements.

Aniliidae (pipe snakes; order Squamata, suborder Serpentes (Ophidia)) Family of subterranean snakes, similar in general form to the blind snakes (Typhlopidae), but with enlarged belly scales. The small eyes are not covered by scales, and remnants of hind limbs remain as claws near the anus. There are 10 species, from S. America and SE Asia. *See also* coral snakes.

animalcule Old name for a microscopic, animal-like organism, particularly a protozoon.

animal pole The end (or pole) of an egg that contains the most cytoplasm and the least yolk. It is also the point on the surface of the egg that is nearest to its nucleus. The opposite end is called the vegetal pole. These two poles form the anchor points from which spindle fibres extend to attach to the centromere of each of the two homologous chromosomes during cell division.

animal starch *See* glycogen.

anion Ion carrying a negative electrical charge.

anion-exchange capacity The total exchangeable anions that a soil can adsorb, measured as milliequivalents per 100 grams of soil.

anis (*Crotophaga*) *See* Cuculidae.

anise (*Pimpinella anisum*) *See Pimpinella*.

Anisoptera (dragonflies; class Insecta, order Odonata) One of the three suborders of dragonflies, comprising insects which are generally more robust, and fly more strongly, than that in the other suborders. The anisopteran hind-wing has a broader base than the forewing, both parts being held outspread when the insect is at rest. The nymphs are aquatic and robust, with an elaborate system of tracheal gills arranged in longitudinal rows within the rectum. Adults are often brightly

coloured, and fly near water. This cosmopolitan suborder has nine families, containing more than 5000 species.

Anisoptera (mersawa; family Dipterocarpaceae) Genus of large, evergreen trees with valuable, usually siliceous, timber. They are native from Assam to New Guinea, and are found in lowland tropical rain forest. There are 13 species.

anisotropic Applied to substances whose optical or other physical properties vary according to the direction from which they are observed.

Anisozygoptera (dragonflies; class Insecta, order Odonata) Smallest of the three suborders of dragonflies, comprising insects that are superficially similar to the Anisoptera, but whose wings have narrow bases (a zygopteran feature). The nymphs also show features held by both the other suborders. The Anisozygoptera flourished during the Mesozoic, when they replaced the ancestral dragonfly order Protanisoptera. Today there are only two, poorly known, living species, found in India and Japan. *See also* Epiophlebiidae; and supersex.

ankerite Mineral, specific gravity 2.9–3.2, hardness 3.5–4.0, and with the chemical composition $Ca(Mg.Fe)(CO_3)_2$, named after the Austrian mineralogist M. J. Anker. It occurs as a gangue mineral with iron ores, and as fillings associated with coal seams, and in an environment similar to that of dolomite. Its most distinguishing feature is its yellowish-brown colour, although it can be white, yellow, or grey; and it has a white streak, and a vitreous lustre. It crystallizes in the trigonal system. The crystals can be rhombohedral, but also massive and granular. *See also* carbonatite.

Ankylosauria (ankylosaurs) Cretaceous dinosaurs, heavily armoured with bony plates, rather in the manner of armadillos. They had small heads with insignificant teeth, and some forms were toothless.

ankylosaurs *See* Ankylosauria.

annatto (*Bixa orellana*) *See Bixa*.

Annelida Phylum of coelomate worms which possess a definite head, and good metameric segmentation. Anatomically they are more complex than the Platyhelminthes. They have vascular, respiratory, and nervous systems which are well developed. The body is elongate, and each segment has bristles. They occur in marine, freshwater, and terrestrial environments. Some are parasitic. They are represented today by the earthworms, sandworms, and leeches. Their fossils are found in rocks dating from the Cambrian, and possible fossil annelid worms are known from Precambrian sediments in S. Australia.

Anniellidae (shovel-snouted legless lizards; order Squamata, suborder Sauria (Lacertilia)) Family of limbless, burrowing lizards, inhabiting sandy ground. The head is wedge-shaped, with a countersunk lower jaw, small eyes with lids, and no tympanum. The scales are smooth. The diet consists mainly of insect larvae. There are two species, both found only in California.

Annona (family Annonaceae) Genus of shrubs or small trees, producing fruits that are aggregate, individual berries being immersed in the fleshy receptacle. Many are edible, e.g. neotropical *A. muricata* (soursop), *A. reticulata* (bullock's heart or custard apple), *A. cherimola* (cherimoyer), and *A. squamosa* (sweetsop or sugar apple). There are 120 species, occurring in warm-temperate to tropical regions, especially in America.

Annonaceae Family of shrubs, monopodial trees, and climbers, with aromatic tissues. The twigs have septate pith. The leaves are simple, alternate, and exstipulate. The flowers are bisexual or unisexual; often fragrant; and their parts are free. They have three sepals, six petals, and many stamens. The few to many carpels are superior, and there are one to many ovules. Fruits typically are clustered, and fleshy. *Asimina triloba* (pawpaw), of N. America, is one of the few temperate species. There are about 120 genera, with about 2000 species, almost entirely tropical, and found mainly in the Old World, especially in lowland rain forest.

annual Applied to a plant that completes its life cycle—from germination to flowering to seed production and the death of vegetative parts—within a single growing season. *Compare* biennial; ephemeral; and perennial; *see also* therophyte.

annual fish Certain small cyprinodont fish whose adult life is confined to a single year. Spawning takes place before the onset of the dry season. Although the adults then die, the hardy eggs survive, hatching with the arrival of the rains. Several *Aphyosemion* species have become popular aquarium fish.

annual meadow grass (*Poa annua*) *See Poa*.

annual ring *See* tree ring.

annulate lamellae Flat, membranous cisternae bearing regularly spaced pores, derived from the nuclear envelope and apparently representing an intermediate stage between this and the endoplasmic reticulum.

annuli Concentric rings or bands of varying width and opacity which are formed in the scales of bony fish. Winter rings are often narrower and denser than summer rings. The number of annuli is indicative of the age of a fish. *See also* age determination.

annulus (mycol.) In the fruit bodies of certain agarics, a remnant of the partial veil that adheres as a ring of tissue around the stipe.

Anobiidae (furniture beetles; class Insecta, order Coleoptera) Family of small, pubescent, brown beetles, 2–7 mm long, in which the head is hooded by the pronotum. The antennae have the last three segments elongate. Larvae are white, fleshy, and C-shaped; they have tiny legs. They bore into the wood and bark of dead trees. Larvae of *Anobium punctatum* (woodworm) attack furniture and structural timbers; distinctive holes are caused by the emergence of adults. *Xestobium rufovillosum* (deathwatch beetle) bores into structural timbers. Adults make a 'ticking' noise, by tapping the head against

wood as a signal to the mate; this is sometimes heard by those keeping vigil with the dying and so is thought to presage death. There are 1100 species.

Anobium punctatum (woodworm) *See* Anobiidae.

anode Positive electrode, to which negative ions (anions) are attracted.

anoestrus In female Mammalia, the period between oestrous cycles, during which the sexual organs are quiescent and breeding does not occur.

anogenital Applied to the region of the body containing the anus and genitalia.

anoles (*Anolis*) *See* Iguanidae.

Anolis (anoles; order Squamata, suborder Sauria (Lacertilia), family Iguanidae) Genus of iguanid lizards, most of which are small, arboreal eaters of fruit and insects, with slender bodies, and long whip-like tails. The clawed toes have adhesive pads, some with enlargements which give a parachute effect. They are adept at colour-change. There are 165 species, distributed from N. Carolina (USA)to S. Brazil, and in the W. Indies.

Anomalodesmata (phylum Mollusca, class Pelecypoda) Subclass of equivalve, or nearly equivalve, pelecypods most of which are relatively elongate. They have an aragonitic shell, and many genera have a nacreous endostracum. The ligament is opisthodetic if present, and the musculature is nearly isomyarian. There is a thickened hinge margin, and dentition is desmodont or edentulous. Living members have eulamellibranchiate, or occasionally septibranchiate, gills. They first appeared in the Middle Ordovician. There is only one order, the Pholadomyoida.

Anomalopidae (lantern-eye fish; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Family of primarily warm-water, Indo-Pacific fish, possessing a cream-coloured light organ beneath each eye. The fish can turn their 'lanterns' off at will by masking the light organ with a piece of black skin. *Anomalops katopteron* can 'flick' its light at the rate of about four to five times a minute.

Anomaluridae (scaly-tailed squirrels; order Rodentia, suborder Sciuromorpha) Family of arboreal, squirrel-like rodents, usually brightly coloured, and in all genera but *Zenkerella* possessing a patagium supported laterally by an olecranon cartilage, used in gliding. The tail is bushy, with a double row of raised scales on the underside, and in some species it is long. The limbs are pentadactyl, the claws strong. The skull is high, the palate narrow, the eyes and ears large. The cheek teeth are rooted, brachyodont with four or five cusps. There are about 12 species in four genera: *Anomalurus*, *Anomalurops*, *Idiurus*, and *Zenkerella*. They are found in W. and C. Africa.

Anopheles (malarial mosquitoes; class Insecta, order Diptera, suborder Nematocera, family Culicidae) Genus of mosquitoes which occur all over the world and which are responsible for the transmission of malaria wherever they occur. Only females feed on blood, after piercing a subcutaneous blood vessel of some vertebrates. Males feed on nectar and other plant juices. The eggs of *Anopheles* are generally laid singly in small bodies of water. The larvae are surface-feeders, and have feeding bristles which are relatively small compared to those of other groups of mosquitoes. Adult *Anopheles* can be distinguished by their resting attitude, with the body making an acute angle with the substrate as the body is held in line with the proboscis.

Anopheles maculipennis (malarial mosquito; class Insecta, order Diptera, suborder Nematocera, family Culicidae) The most important vector of the protozoan malarial parasite in Europe. This species is part of a so-called 'species group' comprising several sibling species (species which are morphologically similar). The female *A. maculipennis* lays 40–100 eggs during her lifetime. *See also Anopheles*.

Anopla (phylum Nemertini) Subclass of nemertinid worms in which the mouth is posterior in position to the brain. A simple proboscis is present.

Anoplarchus purpurescens (high cockscomb) *See* Stichaeidae.

Anoplopomatidae (sablefish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family comprising only two species of marine fish with a streamlined body, and two dorsal fins. They are found in the North Pacific region. *Erilepis zonifer* (skilfish), may reach a length of 1.8 m and is sometimes caught in the nets of commercial fishermen.

Anoplura (sucking lice; class Insecta, order Phthiraptera) Suborder of lice characterized by piercing mouthparts (made up of three stylets), and by the fusion of all three parts of the thorax. All species are obligate parasites of placental mammals and feed on blood, this being digested with the aid of symbiotic bacteria. Some species are vectors of disease in humans and other animals. There are 15 families, 43 genera, and about 500 species known. Approximately 840 species of mammal are known to harbour Anoplura, and more are expected to be discovered.

Anoptichthys jordani (blind cavefish) *See* Characidae.

anorthite Plagioclase feldspar mineral, specific gravity 2.75, hardness 6.0–6.5, chemical composition $Ca(Al_2Si_2O_8)$, which occurs in the more basic igneous rocks, e.g. gabbros and basalts. Its colour is greyish-white, also greenish, bluish, or reddish; it has a vitreous lustre. It crystallizes in the triclinic system. The crystals have a tabular and prismatic habit, but they normally form unevenly shaped grains. It is an important rock-forming mineral. *See also* anorthosite.

anorthosite Plutonic rock composed almost entirely of plagioclase feldspar (90% or more) which may be oligoclase, andesine, labradorite, or bytamite. It occurs in layered complexes or, more frequently, in Precambrian shield areas as non-stratiform intrusions. It was also found on the lunar highlands where it is largely composed of the calcium end-member anorthite.

Anostomidae (head-stander; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish very similar to the Chilodontidae. They often swim head-down. They occur in S. America.

Anostraca (fairy shrimps, brine shrimps; phylum Arthropoda, subphylum Crustacea, class Branchiopoda) Order of mainly freshwater, branchiopod crustaceans lacking a carapace, and with an elongate body comprising 20 or more segments, with limbs borne by segments 11–19. The brine shrimps, *Artemia* species, are found in salt lakes throughout the world and tolerate very high salinities. There are 175 species.

Anser (geese; family Anatidae) Genus of large, long-necked birds with strong bills used for grazing. They are vegetarian and ground-nesting. *A. anser* (greylag goose) and *A. cygnoides* (swan goose) are both extensively domesticated. There are nine or ten species with a Holarctic distribution, and they are migratory.

Anseranas (magpie goose; family Anatidae) Monotypic genus comprising *A. semipalmatis*, an untidy, black and white bird with long legs and semipalmate toes. The face is featherless. The flight feathers are moulted progressively, avoiding a flightless period. These birds are vegetarian. The young are fed initially by the parents. *Anseranas* inhabit the floodplains of N. Australia.

Anser anser (greylag goose) *See Anser.*

Anser cygnoides (swan goose) *See Anser.*

Anseriformes (screamers, waterfowl; class Aves) Order of birds in which the palate is desmognathous. They lay unspotted eggs which hatch to produce nidifugous, downy young. There are two families, Anhimidae and Anatidae.

antarctic air Very cold, continental polar air mass, which originates over the frozen surface of Antarctica and the surrounding pack-ice, and over the coldest waters of the Antarctic Ocean. As this air moves northward over warmer waters it becomes convectively unstable.

antarctic beech (*Nothofagus antarctica*) *See Nothofagus.*

antarctic front Frontal boundary between cold antarctic air and warmer air, usually lying to the north of it.

Antarctic Ocean (Southern Ocean) Term used to describe the oceanic waters surrounding Antarctica. It extends northwards to about 40° S latitude, the limit of northward drift of ice from the Antarctic region, where there is a marked change in water temperature and salinity. The Antarctic Ocean is typified by low water temperatures (−1.8 °C to 10 °C).

ant bear (aardvark, *Orycteropus afer*) *See* Orycteropodidae.

antbirds 1 *See* Formicariidae. 2 (antshrikes) *See Thamnophilus.*

ant-eaters *See* Myrmecophagoidea.

antecedence Hypothesis that a stream crossing a geological structure may be older than that structure. Such a stream is believed to maintain its course across a developing fold or fault. This is a favoured explanation for streams crossing structures in geologically active areas, as do the Arun in the Himalayas, and the Grand Canyon section of the Colorado in the Rockies.

Antedonacea (feather-stars; subclass Articulata, order Comatulida) Superfamily of comatulids (feather-stars) in which the variably shaped centrodorsal plate bears numerous small cirrus sockets. The centrodorsal cavity is generally about one-third of the centrodorsal diameter. Five radial ossicles are present. The superfamily has existed from the Cretaceous to Recent.

antelope *See* Bovidae.

antenna One of a pair of sensory structures which grow from the head of an invertebrate animal. Antennae may be long and filiform as in cockroaches, feathery as in male moths, or club-shaped as in some Diptera. The antenna is richly supplied with nerves and is covered with a battery of sense organs, including various types of mechanoreceptors and chemoreceptors. The antenna is a dead-end space, but haemolymph is circulated through it by means of a pump or heart.

antennal glands *See* Crustacea.

Antennariidae (anglerfish, frogfish; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Family of balloon-shaped, relatively short-bodied fish, with the naked and loose skin often possessing wart-like processes. The first of the three separate anterior dorsal spines is usually modified into a movable rod, the 'fishing pole' often provided with a fleshy lure used to attract prospective prey. The family comprises about 60 species of marine frogfish found in all tropical and subtropical seas. *See also* Brachionichthyidae.

antennate *See* dance language.

antenodal In the Odonata, a cross vein between the wing base and nodus, which runs between vein C (costal vein) and vein R_1 (median vein). The number of antenodals is an important character in the taxonomy of Odonata.

anteriad Pointing forward.

anther Terminal portion of a stamen of a flowering plant. The pollen sacs containing pollen are borne on the anther.

antheridium Male sex organ or gametangium, within which male gametes are formed, in algae, fungi, bryophytes (mosses, liverworts, etc), and pteridophytes (ferns).

anthesis Time of flowering in a plant. This appears to be a response to a combination of factors including day-length, temperature, and rainfall, but may also be initiated by the addition of gibberellins, one of a group of growth-promoting substances.

Anthidium *See* Megachilidae.

Anthocephalus (family Rubiaceae) Genus of fast-growing, medium-sized, pioneer trees of lowland rain and seasonal forests, characteristically of moist alluvial soils. They yield useful timber, and have been planted widely, but mainly unsuccessfully, throughout the humid tropics. There are two species, native to Nepal, and to the region from Yunnan to New Guinea.

Anthoceris (family Solanaceae) Genus of small shrubs bearing tubular flowers with five, spreading lobes. There are approximately 20 species. All are endemic to, and found throughout, Australia, except in the Northern Territory and Tasmania.

Anthocerotales (class Hepaticae) Order of thallose liverworts which have a number of unique characteristics; they are sometimes regarded as a separate class, Anthocerotae (Anthocerotopsida). The capsule is long and narrow and splits into two valves only (*compare* Hepaticae); it remains green for a long period. The green cells of the thallus each contain a single large chloroplast. Two genera occur in Britain: *Anthoceros* and *Phaeoceros*. They are found for example on wet soil in fields, banks, ditches, etc.

Anthocharis cardamines (orange-tip butterfly; order Lepidoptera, family Pieridae) Butterfly in which the forewings of the males are white, tipped with black, and with a large, orange, apical patch. The orange is absent from females. Larvae feed on Cruciferae, and are well camouflaged against the food plant. The species is represented in Europe, including Britain, and in temperate Asia.

anthocodium In colonial coelenterates, the exposed part of the feeding polyp.

Anthocopa *See* mason bee.

Anthocyathea (Irregulares; phylum Archaeocyatha) Class of solitary, rarely colonial invertebrate animals found in Lower, Middle, and Upper Cambrian rocks. The conical cup is from cylindrical to discoid in outer form, often with an irregular outline, having one, or more usually two, porous walls. The intervallum contains rods and bars or septa, always with dissepiments and commonly with tabulae.

Anthomedusae Alternative name for the hydroid order Gymnoblastina.

Anthomyiidae (class Insecta, order Diptera, suborder Cyclorrapha) Moderately-sized family of small to tiny flies with slender bodies, which may be recognized by the position of the posterior cross-vein in the middle of the wing, the pubescent third antennal segment, and costal cilia. Vein Cu_1 and Cu_{1a} reaches the wing margin, but may be faint at the extremes. The larvae are phytophagous, feeding in plant shoots or inside galls. Some genera, e.g. *Erioischia* and *Hylemyia*, are economically important as pests of cabbage and wheat respectively. More than 1000 species have been described. *See also* venation.

Anthonomus grandis (cotton boll weevil) *See* Curculionidae.

Anthophora *See* Anthophoridae.

Anthophoridae (order Hymenoptera, suborder Apocrita) Large, diverse, cosmopolitan family of mainly solitary bees, with a few species which show some degree of sociality. Most species are long-tongued and have a rapid, darting flight. A pygidial plate is present in the females of almost all species, and in most males. The clypeus is usually protuberant, and the anterior coxa is only slightly broader than long. The pollen scopa consists of hairs and is restricted to the hind tibiae and basitarsi. The family includes some of the largest bees, e.g. the neotropical genera *Centris* and *Epicharis*, and the pantropical carpenter bees of the genus *Xylocopa*. Other genera include *Anthophora*, *Amegilla*, *Eucera*, *Tetralonia*, *Synhalonia*, *Exomalopsis*, *Tetrapedia*, and *Paratetrapedia*. With the exception of the carpenter bees (*Xylocopa*, *Ceratina*, and related genera), which bore into solid wood or plant pith, all anthophorids are ground nesters. They line their brood cells with a waterproofing secretion of the Dufour's gland. In at least one species of *Anthophora* this comprises a mixture of triglycerides, which is also mixed with the larval food. Some species of *Centris* and *Epicharis* collect plant oils, as well as pollen and nectar, as larval food. One subfamily, the Nomadinae, consists entirely of parasitic or cuckoo bees, the females of which have lost the pollen scopa and lay their eggs in the nests of other bee species. The Nomadinae include the genera *Nomada*, *Ammobates*, *Epeolus*, *Passites*, and *Neolarra*.

Anthozoa (sea-anemones, corals, sea-pens; phylum Cnidaria) Class of exclusively polypoid, marine cnidarians. They are solitary or colonial, and usually sedentary. The oral end is expanded as an oral disc with a central mouth, with one or more rings of hollow tentacles. A well-developed stomodaeum leads from the mouth to a gastrovascular cavity, generally with one or two vertical grooves. The gastrovascular cavity is partitioned into compartments by complete or incomplete mesenteries, some bearing endodermal gonads. They first appeared in the Ordovician.

anthracite *See* coal.

anthracnose General term for any of several plant diseases in which symptoms include the formation of dark, often sunken spots on leaves, fruit, etc. An example is bean anthracnose, a disease of dwarf and runner beans caused by *Colletotrichum lindemuthianum*. Grape anthracnose, caused by *Elsinoe ampelina*, is a serious disease in parts of N. Europe; leaves develop irregular greyish spots, and portions of dead leaf tissue may drop out.

Anthracotheriidae Large, primitive members of the Artiodactyla, especially common in the middle Tertiary of the Old World. They were pig-like in general appearance. From the nature of the sediments in which they are fossilized, it seems that they were amphibious. This supports the view based on anatomical evidence that they were the ancestors of the hippopotamuses. They arose in the Eocene and became extinct in the Pleistocene.

Anthracothorax (mangoes; family Trochilidae) Genus of large hummingbirds with green backs and

blackish under-parts in males. The bills are slightly decurved. They are nectar feeders, but will take insects. There are seven species, found in C. and S. America, of which three species are endemic to W. Indian islands.

anthrax Disease of animals, including humans, caused by the bacterium *Bacillus anthracis*. The most common form of the disease is the anthrax boil, a localized boil or pustule resulting from infection of a wound by *B. anthracis*. There is also a systemic form in which septicaemia occurs; this form is frequently fatal. Anthrax is uncommon in humans, occurring mostly in people who handle animals or animal products.

Anthrenus (carpet beetle, museum beetle, woolly bear) *See* Dermestidae.

Anthreptes (sunbirds; family Nectariniidae) Genus of small sunbirds, which are less specialized than most members of the family, and have relatively shorter and straighter bills. They feed on nectar, small insects, and fruit. *A. pallidigaster* (Amani sunbird) is endangered, and confined to two forest areas of Kenya and Tanzania. There are 17 species, found in Africa, SE Asia, and Indonesia.

Anthreptes pallidigaster (Amani sunbird) *See Anthreptes*.

Anthribidae (class Insecta, order Coleoptera) Family of robust beetles, 2–15 mm long, with a short, flattened rostrum. The antennae are short and clubbed, or filiform and very elongate, but without scape. Larvae are curved and fleshy; with legs and antennae absent or reduced. They feed inside fungi, dead wood, and plant galls. *Doticus pestilans* develops inside dried apples. *Araecerus fasciculatus* is a pest of coffee beans, cocoa beans, and spices, particularly nutmeg. *Brachytarsus* larvae feed parasitically inside scale insects. There are 2400 species, mostly tropical.

Anthriscus (family Umbelliferae) Genus of herbaceous, fern-like plants, with two or three pinnate leaves, and compound umbels. Usually there are no bracts, but several bracteoles. The flowers are small, and white. The fruits are ovoid to oblong, smooth or spiny, and hardly ridged. *A. cerefolium* (chervil) is cultivated as a vegetable. There are some 12 species, found in temperate Eurasia, and in N. Africa.

anthropic horizon Surface horizon of a mineral soil that is produced by very long periods of cultivation and fertilization by humans. It is dark brown in colour, contains at least 1% organic carbon, is relatively deep (more than 50 cm), has a base saturation of more than 50%, and has more than 250 ppm P_2O_5 soluble in 1% citric acid.

anthropoid Applied to a member of the suborder Anthropoidea of the order Primates.

Anthropoidea (Simiiformes; cohort Unguiculata, order Primates) Suborder comprising the monkeys, apes and humans. Monkeys and apes have a common ancestor and diverged in the Oligocene. The Dryopithecines of the succeeding Miocene were undoubted apes. The traditional palaeontological view is that these Miocene apes gave rise in turn to three new lines, one leading to the gibbons, another to the great apes, the third to humans. However, on the basis of anatomical characteristics and genetic criteria, it has long been maintained that ancestors of both the gibbons and the orang-utan diverged from the ancestral line of the advanced Primates at an early date and that only subsequently did that line split to give one group comprising humans and another comprising the gorilla and the chimpanzee; recent palaeontological evidence now tends to support this second view. In some classifications the New World monkeys are placed in a suborder separate from that used for the Old World monkeys, apes, and humans. The head is rounded, the neck mobile, the brain large with the cerebral hemispheres well developed, the olfactory region reduced, and the occipital and frontal regions enlarged. The face is hairless except for well defined regions; the upper lip is entire and with no moist muzzle; and the upper lip is capable of extrusion. The face is mobile and used in expressing emotion. The orbits are forward-facing, the external ears small, their edges often rolled over, the lower incisors vertical. There is one pair of pectoral mammae. In all families except Callitrichidae all the digits bear flattened nails. The thumbs and big toes are opposable in some families. The tactile sense is highly developed. In many species social life is highly organized and based on sight rather than smell. Some species are arboreal, others ground-dwelling. Of some 180 species known, 138 survive to the present day.

anthropomorphism Attribution by humans of human characteristics to non-human animals, most commonly by supposing non-human behaviour to be motivated by a human emotion that might motivate superficially similar human behaviour.

Anthus (pipits; family Motacillidae) Genus of medium to small, brown birds with long, white- or buff-edged tails. The under-parts are usually streaked. They are terrestrial, some being found in woodland. They are insectivorous and ground-nesting. *A. spinoletta* (rock pipit or water pipit) occurs in both Palaearctic and Nearctic regions. There are 34 species.

Anthus spinoletta (rock pipit, water pipit) *See Anthus*.

Antiarchi (class Placodermi) Group or order of fossil, Devonian, fish, possibly related to sharks. The trunk shield, which was larger than the head shield, possessed a pair of movable spine-like pectoral fins. The fossils may reach a length of about 30 cm, and show a subterminal mouth as well as a heterocercal tail.

Antiaris (family Moraceae) Genus of trees producing poisonous latex which is much sought as a constituent for arrow poisons. *A. toxicaria* (ipoh or upas tree) gained a false reputation in Europe for being excessively poisonous. There are four species, occurring in tropical Africa, Madagascar, and Indo-Malaysia.

antibiosis *See* allelopathy.

antibiotic Antimetabolite obtained from or produced by a living bacterium, fungus, or plant,

which, in very small amounts, is toxic or lethal to other organisms (usually other bacteria or fungi). The term may also refer to chemical derivatives of naturally occurring antibiotics or to synthetic substances with similar properties. Under natural conditions the ability to produce an antibiotic presumably confers a competitive advantage on the organism. Some antibiotics are important in the treatment of diseases caused by micro-organisms.

antibody (immunoglobulin) Complex protein produced in response to the introduction of a specific antigen (which is normally foreign to it) into an animal. Antibodies are usually highly specific, combining only with antigens of a particular kind. Antibodies belong to a class of proteins called immunoglobins, which are formed by plasma cells in the blood as a defence mechanism against invasion by parasites, notably bacteria and viruses, either by killing them or rendering them harmless. The specificity of their binding reaction with a particular antigen is due to the configuration of a particular small area, known as the active site, on the surface of the antigens. Thus when a parasite (or its poisonous products) enters the tissues of its host, the antigens deriving from the parasite each produce a particular response according to the specific antibody that binds to that antigen. This 'recognition' by the host of the species or strain of parasite which has entered is sometimes applicable to other parasites should they share the same antigen. For example, the vaccinia and smallpox viruses share the same antigen so that immunity to one confers immunity to the other. Antibodies may persist in the body long after the disappearance of the antigen, so conferring immunity to any new infection by the same strain or species of parasite. Vaccination or inoculation provides immunity to an organism by the injection of particular foreign proteins (not necessarily from a parasite) which then stimulate the production of antibodies.

anticlinal valley Valley developed along the axis of an anticline. Inward-facing escarpments are developed where the upper beds of the anticline are relatively resistant, while softer lower materials occupy the valley floor. It is a common land-form in gently folded strata of varying resistance, such as occur in southern Britain.

anticline Arch-shaped fold in rocks, with the oldest rocks at the core.

anticoagulant Substance that inhibits the clotting of blood.

anticodon Triplet sequence of nucleotides in transfer-RNA that during protein synthesis binds by base pairing to a complementary sequence, the so-called codon, in messenger-RNA attached to a ribosome.

anticyclogenesis Process whereby an anticyclone or a ridge of high pressure is formed and developed.

anticyclolysis Process of dissipation or weakening of an anticyclone or ridge of high pressure.

anticyclone Area or system of high atmospheric pressure with a characteristic pattern of air circulation, with subsiding air and horizontal divergence of the air near the surface in its central region, which is an air-mass source region. Winds are generally light because of small pressure gradients; they flow clockwise in the northern hemisphere and anticlockwise in the southern hemisphere. A temperature inversion is common at the base of the air subsidence, and this restricts vertical development of cloud. The systems are often slow-moving or stationary. Weather conditions are generally settled. Cold anticyclones form over continents in winter and over polar areas at any time, accompanied by strong inversions: in the clear air, pronounced frosts and very cold surface conditions result. Warm anticyclones (so called because of the warm, subsided air aloft) over land areas typically bring spells of settled and often warm weather. *See also* anticyclonic gloom.

anticyclonic gloom Condition associated with anticyclones accompanied, in the colder months of the year, by well-developed temperature inversion: these can trap dust and other pollutants, and often have radiation fog in the lower layers. The stability of the high-pressure system can make the resultant reduced visibility very persistent and may establish smog conditions.

Antidesma (family Stilaginaceae) Genus of shrubs or small trees producing flowers on spikes, which are minute, unisexual, and have a prominent disc. The fruit is a small, juicy drupe, usually flattened. The genus is often placed in Euphorbiaceae, but has no close relatives there, and perhaps is intermediate to Icacinaceae. There are 170 species, occurring in the Old World subtropics and tropics, especially in Asia.

antidiuretic hormone *See* vasopressin.

antiform Arch-shaped rock structure which, by definition, closes upward, but in which it may not be possible to determine the oldest rocks. It is frequently observed in complex orogenic regions.

antigen Molecule, normally of a protein, although sometimes of a polysaccharide, usually found on the surface of a cell in an animal, whose shape causes the production in the invaded organism of antibodies that will bind specifically to the antigen. *See also* antibody.

antihaemophilic globulin (AHG) *See* blood clotting.

Antilocapridae (order Artiodactyla, infra-order Pecora, superfamily Bovoidea) Family of 'antelope-goats', which appeared first in the middle Miocene. In general appearance, the earliest representatives probably resembled roe deer. The horns have two branches in bucks, and are usually simple in does but sometimes have a small prong. The horns have a hard bony core, and a soft, keratinous covering which is shed. The feet possess two digits. Antilocaprids graze or browse in herds. There is one surviving species, in one genus (*Antilocapra*, the pronghorn), found in western N. America.

antilocaprids *See* Antilocapridae.

antimonite (antimony glance, stibnite) One of the main ore-minerals for antimony, specific gravity 4.6, hardness 2.0–2.5, chemical composition Sb_2S_3.

It occurs mainly in hydrothermal deposits, at the low-temperature end, where it often forms sheet-like bodies, and is associated with fluorite, quartz, and barite, and with sulphides of lead, zinc, and other metals. Its colour is normally lead-grey with a bluish tarnish, and it has a metallic lustre. It crystallizes in the orthorhombic system. The crystals are prismatic, columnar, acicular, and vertically striated, with a perfect lengthwise cleavage.

antimony glance *See* antimonite.

anti-oxidant Compound, usually organic in nature, that prevents or retards the oxidation by molecular oxygen (autoxidation) of materials such as food, rubber, and plastics. It acts by scavenging the free radicals generated in autoxidation chain reactions, and thus provides an alternative oxidation pathway. It does not act indefinitely as it is destroyed in the process.

Antipatharia (black corals; class Anthozoa) Order of colonial, branching corals. Polyps are small, with few tentacles (six simple, or eight branched) and few unpaired mesenteries (6, 10, or 12). The skeleton is a branched, thorny, chitinous, axial structure, developed from the ectoderm, extending throughout the colony, and surrounded by a fleshy coenosarc containing the polyps. Black corals are non-reef-dwellers in depths of 2–35 000 m. About 20 extant genera are known, one of which is also known from the Miocene.

antipodal Usually refers to three haploid nuclei which are formed during megasporogenesis in plants; all are located opposite the micropylar end of an ovule. *See also* megasporangium; and micropyle.

Antirrhinum (family Scrophulariaceae) Genus of plants in which the lower leaves are opposite, the upper leaves alternate, and all are simple. The flowers are borne in racemes, and have strongly two-lipped corollas, the lower three-lobed lip having a projecting bulge or 'palate' which closes the mouth of the flower; the tube is unspumed, but with a swelling below. *A. majus* (snapdragon) is cultivated in many coloured forms and has been naturalized beyond its S. European natural range. There are some 40 species of herbs, most Mediterranean, but also occurring in western N. America.

antiserum Immune serum containing specific antibodies, prepared from the blood of a human or of another animal that has been immunized against antigens from bacteria, viruses, or other parasites.

antitoxin Antibody that neutralizes or inactivates a specific toxin (forming an antigen).

antitrade Upper wind in low latitudes that flows counter (i.e. poleward) to the trade wind below.

antitragus In Mammalia, the lower posterior part of the outer ear, which lies opposite the tragus.

ant lions *See* Myrmeliontidae; and Neuroptera.

ant-loving crickets *See* Myrmecophilidae.

antpittas *See Grallaria*; and *Myrmothera*.

Antrodiaetidae *See* trapdoor spiders.

ants *See* Apocrita; Formicidae; and Hymenoptera.

antshrikes *See Thamnophilus*.

ant woodlouse *See Platyarthrus hoffmannseggii*.

anucleate Lacking a nucleus. For example erythrocytes (red blood cells) in mammals lack nuclei, although they are nucleated in birds.

Anura (Salientia; anurans, tailless amphibians frogs and toads; class Amphibia) Order of amphibians in which the head joins directly into trunk. The vertebral column is short, and there is no tail. The forelimbs are stout; the hind limbs long and webbed, and used for jumping and swimming. The eyes are large, and high on the head. There are superficial ear membranes posterior to the eyes. All anurans lay eggs, have external fertilization, and develop from tailed tadpoles. There is no neotony. Sexual dimorphism is common, the males often being smaller and having vocal pouches. There are 2600 species, widespread in tropical and temperate zones.

anurans *See* Anura.

anus In most Metazoa, but not in Coelenterata or Platyhelminthes, the exterior opening of the alimentary canal through which are expelled the unabsorbed remainder of food items, solid excretion products, and bacteria associated with both. In some aquatic invertebrates the posterior end of the alimentary canal is also used in respiration.

anvil Name commonly applied to the tops of those cumulonimbus clouds that spread in the vicinity of the tropopause into a characteristic anvil-like shape with fibrous edges. The rising column of air in the cumulonimbus cloud is checked by the stable stratification of the air above the tropopause.

aorta In Mammalia, the main artery conveying blood to the whole body.

aortic arches In fish, the arteries supplying the gills, passing from the ventral aorta and then uniting to form the dorsal aorta. In tetrapods they are modified and reduced in number.

Aotus (night monkey) *See* Cebidae.

Apachyidae (class Insecta, order Dermaptera) Family of large, winged, extremely flattened, and brightly coloured earwigs. They may be considered as a subfamily of the Labiduridae. Fewer than 12 species have been recorded from Australia and SE Asia, where they are usually found in rain forest.

apatite Widely distributed phosphate mineral, specific gravity 3.1–3.3, hardness 5.0, chemical composition $Ca_5(PO_4)_3(F,Cl,OH)$, whose name is derived from the Greek for 'deceive'. It is found as an accessory mineral in igneous rock, in pegmatites and high-temperature hydrothermal veins, and in metamorphic rocks. In sedimentary rocks it is the principal constituent of fossil bones. It is distinguished by its hexagonal crystals, and by its hardness (it can be scratched by a steel blade). Its colour is usually a shade of green or grey-green, but it may also be white, brown, yellow, bluish, or red; it has

a white streak, and a vitreous lustre. It crystallizes in the hexagonal system. The crystals are commonly hexagonal prisms, and are often tabular, massive, and granular. Apatite is widely used as a phosphate fertilizer, and for the production of phosphoric acid and various other chemicals.

Apatosaurus One of several gigantic saurischian dinosaurs recorded from the Upper Jurassic. *Apatosaurus* was a sauropod, a quadruped with a long neck, the total weight of which reached 30 tonnes. The name *Apatosaurus* is a senior synonym of *Brontosaurus*. Animals of 22 m in length have been recorded from the Morrison Formation of N. America.

Apatura iris (purple emperor butterfly; order Lepidoptera, family Nymphalidae) Butterfly in which the upper surfaces of the wings of the male have a beautiful, purple iridescence. Adults feed on carrion and dung, as well as on nectar. The larval food plants are sallow (*Salix caprea*) and white poplar (*Populus alba*). The insect overwinters in the larval state. It is found in Europe, including Britain, and throughout temperate Asia.

ape *See* Anthropoidea.

Apeiba (family Tiliaceae) Genus of fast-growing trees, with fibrous bark. Some yield useful timber. There are 10 species, found in tropical America.

apertural Applied to the end or area of a mollusc shell that contains the aperture out of which soft, internal body parts may emerge.

APF *See* absolute pollen frequency.

Aphaniptera An old name for the Siphonaptera (fleas).

Aphanizomenon (order Nostocales) Genus of filamentous cyanobacteria in which the filaments have a somewhat beaded appearance under the microscope. The filaments aggregate into bundles and float at the surface of lakes, ponds, etc. Freshwater blooms of *Aphanizomenon* can lead to poisoning of animals and contamination of water supplies.

aphelion Position in the Earth's eccentric orbit at which the planet is farthest from the Sun. *See also* perihelion.

aphicide Natural or synthetic chemical substance that is toxic to aphids (*Aphis* species), plant-sucking bugs belonging to the order Hemiptera.

Aphididae (aphids, greenfly, blackfly; order Hemiptera, suborder Homoptera) Family of homopterans which feed on plant sap. They are soft-bodied insects, with the rostrum arising between the front pair of legs. Typically there is only one generation a year that reproduces sexually, laying overwintering eggs, usually on woody plants; and several generations of asexually and viviparously reproducing females, either on the woody host or on herbs. Many species are tended by ants which feed on the honeydew (sap that has passed through the bodies of the aphids). Some aphids are serious pests. There are about 4000 species, occurring mainly in the temperate northern hemisphere.

aphids *See* Aphididae.

aphotic zone (disphotic zone) Deep-water area of marine ecosystems below the depth of effective light penetration (the compensation level), analogous to the profundal zone in freshwater ecosystems.

aphthous fever *See* foot-and-mouth (hoof-and-mouth) disease.

Aphthovirus Genus name sometimes used to refer to the virus responsible for foot-and-mouth (hoof-and-mouth) disease; the virus belongs to the Picornaviridae.

Aphyllophorales (subclass Holobasidiomycetidae) Order of fungi in which the development of the fruit body is gymnocarpic; the fruit body may be woody, corky, or leathery, and the hymenium is typically borne on teeth or within tubes. There are many families. Most are saprotrophic, and found on wood, soil, plant debris, etc.

Aphyosemion arnoldi (Arnold's lyretail) *See* Cyprinodontidae; and annual fish.

apical *See* raceme.

Apidae (bumblebees, honeybees, orchid bees, stingless bees; order Hymenoptera, suborder Apocrita) Family of bees, in which the pollen-transporting apparatus is on the outer face of the hind tibia and comprises a corbiculum (a polished, slightly concave area bounded by stiff bristles). The hind tibial spurs are absent, except in the genus *Bombus*. Genera include the neotropical orchid bees *Eufriesia*, *Eugloss*, and *Eulaema*; and the primitively eusocial *Bombus* (bumblebees). The stingless bees of the genera *Melipona* and *Trigona*, and the four species of honeybees—*Apis cerana*, *A. dorsata*, *A. indica*, and *A. mellifera*—have achieved the highest levels of insect sociality other than those found among the termites and ants, with a morphologically distinct worker caste.

Apionidae (weevils; class Insecta, order Coleoptera) Insects very closely related to Curculionidae, but distinguished by having non-elbowed, clubbed antennae. They have a highly convex, punctured elytra, 1.5–20 mm long; and the head is produced into a long, curved or stout rostrum. The larvae are legless and grub-like, and feed inside seed pods, stems or plant roots. *Apion* larvae are often pests of legumes: females bite a hole in the pod, lay eggs on developing seeds, and plug the hole. *Cyclas formicarius*, the sweet-potato weevil, is a crop pest. There are 1060 species.

Apis *See* Apidae; hive; honeybee; and honeycomb.

Apistogramma ramirezi (butterfly cichlid) *See* Cichlidae.

apitong *See Dipterocarpus*.

Apium (family Umbelliferae) Genus of glabrous herbs with mostly pinnate leaves, and leaf-opposed umbels. The fruits are broad-ovoid to oblong, laterally compressed carpels with five low ridges. *A. graveoleus* (celery) is a valuable vegetable. There are about 45 species, of cosmopolitan distribution.

Aplacophora (Solenogastres; phylum Mollusca, class Amphineura) Subclass of benthic, worm-like molluscs, which lack a dorsal covering of valves. Calcareous spicules may occur in the mantle that covers the body. The anatomy and nervous system are very similar to those of the Polyplacophora. The ventral foot is represented as a groove in the order Neomeniida, but is absent in the second order, Chaetodermatida. They are entirely marine, and have a worldwide distribution. This group does not occur in the fossil record.

aplanate Lying in a plane; leaves may be displayed on the twigs of a plant to give aplanate foliage.

aplanetism Condition in which no motile stage is formed.

aplanogamete Non-motile gamete.

aplanospore Non-motile spore.

aplasia Failure of development of an organ.

Aploactinidae (Haploactinidae; velvetfish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of marine, coastal fish of the W. Pacific. The sharply tapering body shows a long dorsal fin originating on the head, with the pelvic fins reduced to a weak spine and two or three rays. The scaleless skin bears papillae, giving it a velvety appearance. They are relatively common in weedy areas of Australia. *Aploactisoma milesii* may reach a length of 23 cm.

Aplochitonidae (Haplochitonidae; southern smelts; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of freshwater and brackish-water fish with an elongate body, and a single dorsal as well as an adipose dorsal fin. The Australian grayling, *Prototroctes maraena*, and the Derwent whitebait, *Lovettia sealii*, ascend the rivers in order to spawn. Other species occur in S. America.

Aplodactylidae (sea carps; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, herbivorous fish, somewhat blunt-nosed, with a single but deeply-notched dorsal fin. *Dactylosargus arctidens* (southern sea carp) is fairly common in S. Australian waters. Other species occur in Australia, New Zealand, and S. America.

Aplodontia (mountain beaver) *See* Aplodontidae

Aplodontidae (mountain beaver; order Rodentia, suborder Sciuromorpha) Family of burrowing rodents. The body is thickset and heavy, the limbs and tail short, the claws large. The eyes and ears are small. The skull is flat, wide posteriorly, and the palate broad. The animal is found only in the N. American Rockies. There is one genus (*Aplodontia*), and one species.

Aplonis (glossy starlings; family Sturnidae) Genus of black birds with a green gloss. The iris is red, yellow, or white. Glossy starlings have medium to long tails. They are mostly gregarious and forest-dwelling. They feed on fruit and insects, and are mainly hole-nesting. There are 19 species, found in the Oriental and Australasian regions, and on Pacific islands; and two species are extinct. *A. panayensis* (glossy starling) is widely kept as a cage bird.

Aplonis panayensis (glossy starling) *See Aplonis*.

Aplysiacea *See* Anaspidea.

Aplysiomorpha *See* Anaspidea.

apocarpous With the carpels free.

apocrine gland Gland whose secretion is produced by the disintegration of its active cells. *Compare* merocrine.

Apocrita (ants, bees, wasps; subclass Pterygota, order Hymenoptera) The larger of the two suborders of Hymenoptera, whose members have a constriction between the thorax and abdomen, occurring between the narrowed first abdominal segment (which is attached to the thorax) and the rest of the abdomen. Wing venation in some minute forms is greatly reduced, and the ovipositor can be of two types: a non-stinging type normally kept outside the abdomen, and a stinging type which is retractable. Apocrita is a very large suborder, comprising 11 superfamilies, with about 105 000 species, many of which are of benefit to humans. Species whose larval stages are herbivorous include bees, gall wasps, and some Chalcidoidea, but the majority of Apocrita are parasites of other insects and spiders.

Apocynaceae Family mostly of trees, climbers or shrubs. The leaves are mostly opposite, or whorled. The flowers are cymose, regular, and bisexual; they have a five-lobed calyx and corolla tubes, five stamens, the ovary superior or half inferior, and two carpels, which are free or fused. Fruits are paired, fleshy or woody, and dehiscent. There are about 180 genera, with about 1500 species, whose distribution is tropical with a few temperate outliers.

Apoda (class Amphibia) One of the living groups of amphibians now confined to the tropics. They have become adapted to a burrowing life and look like large earthworms. They are the only living amphibians to have retained scales, although these are vestigial and hidden in folds of skin. *See also* caecilians.

Apodacea (class Holothuroidea) Subclass of sea-cucumbers with simple or digitate tentacles. The tube feet are reduced or absent; there are no pharyngeal retractor muscles; the test is vestigial. They first appeared in the Carboniferous.

apodeme Piece of inflected cuticle that forms the attachment for muscles in the body of an insect. Because an insect has no endoskeleton, all muscles attach to elements of the exoskeleton. These are frequently inflected, either to act as tendons, or, in effect, as an endoskeleton. *See* exoskeleton.

Apodemus sylvaticus (field mouse, wood mouse) *See* Muridae.

Apodes Alternative name for the group or order of eels and related fish.

Apodida (subclass Apodacea) Order of tropical reef-dwelling holothuroids which lack respiratory

trees, gas exchange occurring through the general body surface. Tube-feet and radial canals are also absent.

Apodidae (swifts; order Apodiformes) Family of medium to small birds with small, short bills and a wide gape. They have long, curved, narrow wings; a short tail, often spine-tipped; and short, weak legs with reversible hallux. They are highly aerial, fast-flying, and insectivorous. Their nests are built on trees, buildings, rocks, and in caves, often using saliva. There are 12 or more genera, containing about 80 species. Nearly all are tropical, northern-breeding birds migrating to the tropics in winter, but they are found worldwide.

Apodiformes (swifts, tree swifts, hummingbirds; class Aves) Order of birds all of which have a short, thick humerus, a short ulna, and short secondary feathers. They are high-speed fliers. The order comprises three families. Trochilidae (hummingbirds) are placed in a different suborder from Apodidae (swifts) and Hemiprocnidae (tree swifts).

apodous Without legs.

apoenzyme Portion of a conjugated enzyme that is a protein.

apogamy *See* apomixis.

apogeotropism The type of tropism in which plant organs (e.g. shoots) grow against the force of gravity.

Apogonidae (cardinal fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of mainly marine fish not exceeding 20 cm in length. They exhibit two separate dorsal fins, and have relatively large eyes and mouth. Most cardinal fish display the unusual habit of incubating the fertilized eggs in the mouth cavity until they hatch. In some species the males are the mouthbrooders, in others the female performs this duty. There are about 170 species. They are shallow-water fish of all temperate and tropical seas.

Apollo butterflies *See* Papilionidae.

apomict Plant produced by apomixis, a form of asexual reproduction.

apomixis Asexual reproduction in plants without fertilization or meiosis. Agamospermy occurs when a diploid embryo sac (sporophyte) develops by the somatic division of a nucellus or integument cell; no meiosis takes place so that the diploid sporophyte gives rise directly to a diploid gametophyte. Apogamy occurs (in ferns) when the converse occurs, a diploid gametophyte giving rise directly to a diploid sporophyte. Apomixis is also used to denote vegetative reproduction in which part of a plant may become detached and develop into a separate individual without any sexual reproduction.

apomorph Evolutionarily advanced ('derived') character state. The long neck of the giraffe is apomorphic; the short neck of its ancestor is plesiomorphic.

apomorphic Applied to features possessed by a group of biological organisms that distinguish those organisms from others descended from the same ancestor. The term means 'new-featured' and refers to 'derived' characters which have appeared during the course of evolution.

apophysis 1 In vertebrates, a projection from a bone, usually for muscle attachment. 2 In echinoids, an internal projection from one of the interambulacral plates around the peristome; apophyses serve for the attachment of the muscles supporting the lantern.

apoplast Dead tissues of the xylem, together with those parts of the plant that lie outside the plasmalemma. They constitute a possible route of transport through the plant.

aposematic coloration (aposematism) Warning coloration in which conspicuous markings on an animal serve to discourage potential predators. Usually the animal is poisonous (e.g. has a venomous bite or sting) or unpalatable. Examples include the conspicuous bands or stripes on the back and sides of venomous snakes (e.g. coral snakes), and contrasting markings on the wings of distasteful monarch butterflies.

aposematism *See* aposematic coloration.

apospory Development of a diploid embryo sac in some plants by the somatic division of a nucellus or integument cell without meiosis. It is a form of agamospermy, in which a seed is produced without fertilization.

Apostasiaceae Family of monocotyledonous herbs with plicate leaves. The flowers are racemose, with six free perianths, 2–3 stamens, the filaments and style united, the ovary inferior and trilocular, and numerous axile ovules. The fruit is a capsule. The family is primitive, and closely related to Orchidaceae. There are two genera, with about 20 species, found from India to tropical Australia.

apostatic selection Selection favouring diversity in appearance and genetic variability among the individuals of a species population. Mimicry, for example, is a polymorphism in which individuals of a species that is palatable to predators mimic other species that are unpalatable. Because it generates population diversity, atypicality is a positive advantage to individuals and to the species overall: the fewer mimics there are in relation to the numbers of their genuinely unpalatable models, the more frequently the predators will repeat the unpleasant experience of eating an unpalatable individual. This reinforces the association of appearance with unpalatability. Predators will tend to avoid apparently unpalatable individuals. This will favour reduced predation of the mimic species. Were all individuals to mimic the same model, however, this advantage would be lost, as the proportion of mimics to models would rise. It would then be less common for predators to encounter unpalatable prey and the reinforcement would be reduced. Thus by mimicking a variety of models, the population of the mimic species may be increased.

Apostomatida (subclass Holotrichia) Order of ciliate protozoa in which mature forms have

spirally-arranged body cilia. There is a complex life cycle. The organisms live parasitically in various marine crustaceans.

apothecium Roughly cup-shaped or dish-shaped ascocarp, in which the asci line the inner surface and are thus exposed to the atmosphere.

appeasement Behaviour by an animal that serves to reduce aggression shown towards it by another member of the same species, but that does not involve avoidance or escape.

appendix In some Mammalia, a vermiform, cul-de-sac termination to the caecum, close to the junction of the large and small intestines. In herbivorous animals (e.g. Lagomorpha) whose large intestine is involved in the digestion of cellulose, the caecum and appendix are large. In others (e.g. humans) in which the main purpose of the large intestine is the conservation of fluid, they are small.

appetitive General and rather imprecise adjective used to describe behaviour exhibited by an animal that is exploring its environment or seeking a goal. *See* consummatory.

apple *See Malus*.

apple berry *See Billardiera longifolia*.

apple gall *See* Cynipinae.

apple moss Common name for the moss *Bartramia pomiformis* (order Bryales). The name derives from the resemblance of the immature capsules to miniature green apples; as they age the capsules become brown and wrinkled. The moss is found on sandy soil, rock ledges, etc.

apple scab Very common disease of apples in which the most obvious symptom is the appearance of superficial, dark, corky scabs on the fruit. In general the disease is not serious in itself, although more serious secondary infections can occur. The causal agent of apple scab is a fungus, *Venturia inaequalis*.

applied ecology The use of ecological concepts—e.g. succession, population growth and decay, and biogeochemical cycling—in issues directly relevant to human societies. Examples include studies of cereal ecosystems; forest ecology; pollution studies (e.g. of the reclamation of derelict land, of the disposal of toxic wastes, and of eutrophication and oligotrophication in rivers and lakes); advice on proposed changes in land use (e.g. the construction of tidal barrages); and biosphere conservation management.

appressorium In certain parasitic fungi, an attachment organ consisting of a flattened hypha which presses closely to the tissues of the host as a preliminary stage in the infection process.

Apteronotidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish occurring in S. America. Members of the family possess a body tapering down to a narrow tail with a tiny tail fin. Related to the electric eels, the apteronotids can also produce weak electric charges.

apterous Literally, without wings (from the Greek *a*, not, and *pteron*, wing), and applied to species that are primitively wingless, or secondarily so due to a parasitic life-style.

Apterygidae (kiwis; order Apterygiformes) Family of fowl-sized, brown-grey ratites. They have short, muscular legs, and a long flexible bill with nostrils at the tip. Their feathers are loose and hair-like. They have vestigial wings and no tail. They are small-eyed and mainly nocturnal, inhabiting thick forests and nesting in burrows. They feed on grubs and worms. The family comprises one genus (*Apteryx*) containing three species, all of them endemic to New Zealand.

Apterygiformes (kiwis; class Aves) Order comprising one family, Apterygidae.

Apterygota (class Insecta) The smaller subclass of the Insecta, which is now recognized as containing two orders: Archaeognatha and Thysanura. Members of these orders are primitively wingless (in contrast to secondarily wingless insects, e.g. fleas, lice, etc.), terrestrial insects with ectognathous, biting mouthparts. The subclass formerly included the Protura, Collembola, and Diplura, which are now regarded as distinct classes of hexapod. Most Apterygota are free-living; elongate or oval; 3–15 mm long; and with direct larval development, moulting occurring throughout the life of the animal. They feed on fungi, lichens, pollen, etc., domestic species subsisting on a diet of carbohydrates, dextrins, and a small amount of protein from glue and sizes. Approximately 580 species occur worldwide, and apterygote insects can be found almost everywhere, even at high altitudes and in polar regions.

Apteryx (kiwis) *See* Apterygidae.

Aptian One of the stages of the Lower Cretaceous Period in Europe.

Apus (swifts; family Apodidae) Genus of dark-brown birds, some with white rumps or bellies. Their tails are forked or square-ended. They are insectivorous, and nest on cliffs or buildings. *A. horus* (horus swift) nests in sand burrows. There are 15 species, found mainly in Africa, but also in Europe, Asia, and Australia.

Apus horus (horus swift) *See Apus*.

aquaculture System of fish farming based on a short food-chain supported by the input of fertilizer, feedstuffs, hatchery-reared stock, and work energy. Some systems aim to use waste materials, e.g. heated water from power stations, and treated organic wastes. Organisms farmed are typically molluscs, crustaceans, and suitable forage fish. *See* mariculture.

aquamarine *See* beryl.

aquifer Body of rock, unconsolidated gravel, or sand stratum that is capable of storing significant quantities of water, that is underlain by impermeable material, and through which ground water moves. An unconfined aquifer is one in which the water table defines the upper water limit. A confined aquifer is sealed above and below by

impermeable material. A perched aquifer is an unconfined groundwater body supported by a small impermeable or slowly permeable unit.

Aquifoliaceae Family of trees or shrubs with leathery, alternate, evergreen, sometimes spiny, simple exstipulate leaves. They are usually dioecious. The flowers, borne in small cymes, are regular, tetra- or pentamerous. The petals and stamens are usually free. The fruit is a small drupe with three or more stones. *Ilex aquifolium* (holly), native in western and central Europe, is much grown for its foliage and for the scarlet fruits of the female trees. There are five genera, with more than 300 species, found throughout the world, except in arctic regions, but centred on the tropics.

Aquila (eagles; family Accipitridae) Genus of large, brown, aggressive birds of prey that inhabit open country. Most are carrion feeders or piratical. They nest on trees, crags, or the ground. There are 10 species, found worldwide except for S. America and Malaysia. *A. chrysaetos* (golden eagle) has a Holarctic distribution.

Aquila chrysaetos (golden eagle) *See Aquila*.

Aquilaria (family Thymelaeaceae) Genus of trees with timber that is pale and soft, sometimes becoming diseased to form a hard, dense, resiniferous heartwood (aloeswood or eaglewood) yielding a valuable oil for medicinal use and incense. There are 15 species, occurring in India, and from S. China to Malesia.

Aquilegia (columbines; family Ranunculaceae) Genus of poisonous perennial herbs, which are usually erect, with alternate, two or three times ternate, compound leaves. The flowers are showy, regular, pentamerous, with petaloid sepals and long-spurred petals, and many free stamens and carpels which produce several-seeded follicles in fruit. Several species and hybrids are cultivated for their flowers. There are about 55 species, found mostly in the northern temperate zone.

Aquitanian Defined first from France, the Aquitanian Stage marks the beginning of the Miocene. It also marks the start of the Upper Cenozoic or Neogene Period of time. The Aquitanian is itself characterized by the appearance of the planktonic foraminiferid *Globigerinoides primordia*.

Ara (macaws; family Psittacidae) Genus of medium to large parrots with long, graduated tails and huge bills. They are brilliantly coloured in red, blue, yellow, or green. They are frugivorous and found in rain forests, where they nest in holes in trees. There are 12 species, found in C. and S. America, and extinct species occurred in the W. Indies. *A. macao* (scarlet macaw) is widely kept in captivity.

arabinose Aldose containing five carbon atoms.

Arabis (family Cruciferae) Genus of calcicole herbs in which the stems are erect, and the leaves are usually oblong, sessile, and numerous up the stem. The flowers are four-petalled, white, or pale yellow. The fruits are compressed, much elongated, and beakless. Many species are cultivated for their flowers. There are about 100 species, occurring throughout the northern temperate zone, and in the mountains of Africa.

Araceae Major family of monocotyledons, comprising tiny to giant herbs, and many bole climbers, which produce sap with irritant crystals. The leaves commonly have net-veins. Flowers are borne in a spike (spadix) subtended by an often colourful spathe; and are small, usually unisexual, the male apical, a perianth usually lacking. The fruit is a berry. There are about 110 genera, and about 2000 species, with pantropical distribution (especially America), with temperate outliers.

Arachiannelida (phylum Annelida) Class of small, simple, annelid worms which are segmented, and most of which have narrow, tube-like bodies. The nervous system is primitive, and parapodia and tentacles may be present. Separate male and female forms generally occur. There are three families, all found in aquatic habitats.

Arachis (family Leguminosae, subfamily Papilionatae) Genus of perennial herbs which are geocarpic. After flowering the inflorescence axis elongates so that the pods open below ground. *A. hypogaea* (peanut, groundnut, monkey nut) is not known in the wild, but is widely cultivated for the edible seed and oil; it is also used for soap and lubrication; the residues make cattle feed, and the green haulms make excellent fodder. There are 15 species, occurring in America from the Amazon River south to Argentina.

Arachnida (Amblypygi, harvestmen, mites, Palpigradi, pseudoscorpions, scorpions, spiders, Uropygi, whipscorpions; subgrade Eucoelomata (Arthropoda), phylum Chelicerata) Class of terrestrial chelicerates which have book lungs or tracheae derived from gills, indicating their aquatic derivation. They have invaded most terrestrial habitats and have secondarily invaded aquatic habitats, although to a very much smaller extent (there is only one species of aquatic spider, and only one species of mite in ten is aquatic). Except for many plant and animal parasites found among the mites, and some scavenging Opilionidae, most arachnids are predatory. Of recent terrestrial animals, the arachnids are probably the oldest known class, scorpions having been recorded from the Silurian Period. A Silurian scorpion *Palaeophonus nuncius* was perhaps the first terrestrial animal. The first fossil spiders are known from the Devonian. The class is extremely diverse, but apart from the mites the body is in two portions, the prosoma (anterior portion) bearing the four pairs of legs, the eyes, the pedipalps, and the chelicerae; and the opisthosoma (posterior portion) containing most of the internal organs and glands. The two portions may be broadly jointed, or connected by a stalk or pedicel. The prosoma has a dorsal shield or carapace, and the opisthosoma is segmented in most orders, but not in spiders and mites and only very weakly in harvestmen. The number of eyes varies up to 12 in some scorpions, but generally vision is poor, many species being nocturnal and equipped with sensory hairs to detect prey. Pedipalps function as hands, and the chelicerae as jaws or teeth. In all arachnids

the mouth is small, and food is generally predigested by enzymes from the mid gut. Reproductive organs are placed on the ventral surface of the abdomen, and courtship may be complex and prolonged, with parental care of the young common to all. All arachnids are dioecious (having male and female sexes). The production of silk and poison is characteristic of some orders, but the methods of production and their origins are varied. Silk is produced from abdominal glands in spiders, from the mouth region in mites, and from the chelicerae in pseudoscorpions. Poison is produced from the chelicerae of spiders, the tails of scorpions, and the pedipalps of pseudoscorpions. There are 11 orders, with 50 000 species. Members of five orders occur in N. Europe, the remainder being tropical in distribution.

arachnoid Resembling a spider's web.

Aradidae (barkbugs; order Hemiptera, suborder Heteroptera) Family of bugs most of which live under the bark of dead trees and logs. Most feed on fungi that attack both broadleaved and coniferous trees, but a few suck the sap of living trees. There are several hundred species, occurring from the lowland tropics to the tree-line.

aragonite Mineral, specific gravity 2.9, hardness 3.5–4.0, and with the chemical composition $CaCO_3$, whose name is derived from the Aragon province of Spain. It occurs in hot springs and in association with gypsum; also in veins and cavities, and in the oxidized zone of ore deposits with other secondary minerals. Mollusc shells are made up of aragonite crystals. Aragonite is a polymorph of calcite, from which it is distinguished by its lack of cleavage and its higher specific gravity. It may be colourless, white, grey, or yellowish, with a white streak and a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are normally prismatic, often acicular, sometimes tabular and pseudo-hexagonal, and also fibrous and stalactitic. Many fossil shells were originally made of aragonite. *See also* carbonates.

Araliaceae Family of herbs, shrubs, climbers, and soft-stemmed pachycaul trees, which is the tropical counterpart to the Umbelliferae. The leaves are often large, and usually compound. The flowers are usually borne in compound umbels, and are small and regular, with four or five reduced sepals; five or three free petals and stamens; a disc; and the ovary inferior with five loculi and one, pendulous ovule. The fruit is a five-seeded drupe. There are about 55 genera, with about 700 species, most of them tropical.

Ara macao (scarlet macaw) *See Ara*.

Aramidae (limpkin; order Gruiformes) Monotypic genus (*Aramus guarauna*), a brown-olive bird, streaked with white, that is structurally crane-like and rail-like in appearance. The bill is long, laterally compressed, and decurved. The bird has a long neck, broad wings, a short tail, and long legs with long, unwebbed toes. It feeds on snails, nests on the ground or in bushes, and is found in wooded swamps in the southern USA, and in C. and S. America.

Aramus guarauna (limpkin) *See* Aramidae.

Araneae (spiders; class Arachnida) Very large and diverse order of predatory arachnids most of which feed on arthropods, although the large mygalomorphs will catch nestling birds and other vertebrates, and some will catch tadpoles and small fish. The prosoma has a uniform dorsal carapace bearing 2–8 eyes. The chelicerae are large but have a fang (rather than a pincer) which bears the opening of a poison gland lying entirely within the chelicera in primitive species, or extending into the prosoma. The pedipalpi are leg-like and the complex structures of the male pedipalp are crucial in sperm transfer, the pedipalp introducing the sperm into the female epigyne (a sexual opening on the ventral surface of the abdomen) with a pumping action. The abdomen (opisthosoma) is usually unsegmented and attached to the prosoma by a narrow, stalk-like pedicel. The abdomen is extremely manoeuvrable, bears the silk spinning organs (spinnerets), and contains two pairs of respiratory organs (book lungs and posterior tracheae), the reproductive organs, and internal glands. Almost all species use their eight walking legs for running rapidly, and some jump by means of rapid rises in internal pressure. The legs have seven segments, the distal segment (pretarsus) having two comb-like claws and often a hook-like median claw for silk manipulation. Spider sensory apparatus varies from sensory setae, trichobothria, and slit sense organs to chemical and tactile receptors on the tarsi and pedipalpi. Vision is important and acute in the Salticidae (jumping spiders). In many species prey items are caught by special webs, sheets, or snares of silk which may be stationary or thrown, and may have drops of sticky adhesive; while other species hunt on the ground, pouncing on their prey. Poison and digestive juices are injected and the digested contents are sucked out. All spiders are dioecious, usually with smaller males, and exhibit elaborate courtship displays involving sexual signalling, nuptial gifts, and some risk to the males in some species. Most species enclose their eggs in a silken sac and guard the eggs and young. As well as using silk for prey capture and egg sacs, spiders may 'balloon', using long threads of silk to carry them as high as 1000 m or more, and may travel 100 km. Spiders are found in all terrestrial niches and there is one aquatic species, some shore dwellers, and others which hunt on the surface film of water, their tarsi being specially adapted with hydrophobic hairs. The 30 000 or so known species are found on all continents except Antarctica, and in all climates.

Araneidae (orb-web spiders; order Araneae, suborder Araneomorphae) Family of spiders which spin typical orb webs and whose legs are armed with many long spines. The chelicerae possess many teeth, and many species of orb spinners have dwarf males. The orb web may be of complex construction, with viscid spirals and many radii. Prey caught on it is bitten, cut out of the web, and wrapped up. In many species, the spider may lie in wait at the hub or centre of the web; in others it may lie concealed close by, at the end of a taut signal thread. There are more than 2500 species, of which *Araneus* is the largest genus.

Araneus diadematus (garden-cross spider, garden spider; suborder Araneomorphae, family Araneidae) Species of orb-spinning spider whose common name refers to its frequent occurrence in gardens and the patterns on its abdomen. The webs can be up to 40 cm in diameter, and can be found in woods and on heaths as well as in cultivated gardens, from late summer to autumn. The spiders have generally poor eyesight and may take prey items with strong warning coloration. Females are 12 mm long, and males 8 mm. This spider is widespread and common throughout Europe, and has been introduced into N. America.

Arapaima gigas *See* Osteoglossidae.

Araucaria (family Araucariaceae) Genus of tall, columnar, coniferous trees, in which the crown is monopodial with radial limbs. The leaves are sharply pointed, crowded, and tough. The timber is valuable. *A. bidwillii* (bunya bunya) of Queensland produces edible seeds. *A. angustifolia* (parana pine) is a major timber tree in Brazil. Norfolk Island pine is *A. heterophylla*. Monkey puzzle (*A. araucana*), native to the S. Andes in Chile and Argentina, produces edible seeds. There are 18 species, of tropical to temperate forests in New Guinea, Queensland, Melanesia; two of the species are found in S. America, and 13 of them in New Caledonia.

Araucariaceae Family of conifers comprising large trees which produce valuable timber. Several species are cultivated. The leaves are broad to lanceolate. The male cone is a catkin; the female is globose, and often massive, disintegrating at maturity. There are two genera (*Agathis* and *Araucaria*), native to the southern hemisphere (but with fossils in the northern hemisphere), and found mainly in Malesia and Melanesia, but also in S. America, and extending north of the equator in Malaysia.

Arbacioida (superorder Echinacea) Order of regular echinoids in which the imperforate, non-crenulate primary tubercles are poorly developed. Adventitious skeletal material on the test surface, simulating tubercles, is commonly developed, but does not bear spines. They first appeared in the Middle Jurassic.

Arborophila (tree partridges; family Phasianidae) Genus of beautifully marked partridges with short bills and tails, and rather long, spur-less legs. They inhabit forests and adjacent scrub. There are 15–18 species, found from E. India to China and Malaysia.

arbor vitae *See Thuja*.

arbovirus A (non-taxonomic) term applied to a virus that can replicate both in vertebrates and in arthropod vectors.

arbuscule Tuft of branching fungal hyphae formed in certain types of mycorrhiza.

Arbutus (family Ericaceae) Genus of evergreen shrubs or small trees with dark green leaves, and clusters of small white, or pink, bell-shaped flowers. The fruit is a globose, warty berry with mealy flesh, edible in *A. unedo* (strawberry tree, native in Ireland and SW Europe). American *A. menziesii* (madroña laurel) has useful timber. There are 20 species occurring in N. and C. America, S. Europe, the Canary Islands, and W. Asia.

Arcellinida (Testacida; class Rhizopodea) Order of shelled (testate) amoebae. The test, or shell, has an aperture through which the pseudopodium emerges. The organisms are found primarily in freshwater habitats.

Archaean *See* Precambrian.

Archaebacteria Taxon recently proposed to include a group of bacteria that show a number of properties distinct from those of other bacteria. The group includes the methane-producing bacteria, the halophilic bacteria, and a few other isolated genera.

Archaeocalamites radiatus First described by Brongniart, in 1828, this species is one of the earliest recorded equisetaleans or 'horsetails', a group of plants noted for the jointed nature of the stem. At each joint there is a ring of short branches.

Archaeoceti (ancient whales; cohort Mutica, order Cetacea) Extinct suborder comprising the oldest and most primitive cetaceans which flourished in the Eocene and which may have originated in Africa. They were comparable in size with modern porpoises, had an elongated snout, and nostrils on top of the skull. The braincase was long and low. The front teeth were peg-like, the cheek teeth heterodont and characteristic of primitive carnivores. There were 44 teeth in all. The hind legs were reduced to vestiges which did not protrude from the body. They were fish-eating carnivores that had adopted an aquatic life to which they were more highly adapted than, for example, modern seals.

Archaeocyathea Extinct group of reef-forming organisms known only from the Cambrian. In some respects they were similar to both sponges and corals, and may represent a true advance in evolutionary grade over the former. It is possible that they lived in a symbiotic relationship with some trilobites. The cause of their extinction is not known.

Archaeocyathida (class Anthocyathea) Order of Lower and Middle Cambrian Archaeocyatha. Some were solitary, others colonial. They have a cylindrical, conical, or discoid cup, often of irregular outline or with outgrowths. The outer wall has simple pores or is partially displaced by dissepiments. The inner wall usually has one longitudinal row of pores between intercepts. The intervallum contains dissepiments, rods, and bars or septa. The order contains two suborders and 19 families.

Archaeogastropoda Group comprising what may be the most primitive gastropods. Members of the class Gastropoda may be subdivided according to their respiratory apparatus. In the Archaeogastropoda this seems to be in the most primitive condition and consists of just two gills. *Patella vulgata* (the limpet) belongs to this group.

Archaeognatha (class Insecta, subclass Apterygota) One of the two orders of the Apterygota, comprising fusiform, subcylindrical insects which can run fast and jump by flexion of the abdomen. The body is covered with pigmented scales, and the thorax is strongly arched. Ocelli are present, and the compound eyes are large and contiguous. The mandibles are monocondylar (with a single articulation), and the maxillary palps are long and seven-segmented. The abdomen has ventral styles on segments 2–9, used for running on sloping ground, and the posterior portion of the abdomen bears a pair of cerci and a single, much longer, appendix dorsalis. These insects are free-living and nocturnal, feeding on lichen, algae, and vegetable debris. Post-embryonic development is slow (six months to two years), and moulting occurs throughout the entire life-span. The 250 or so species are of little economic importance.

Archaeopteris Early progymnosperm found first in the Frasnian stage of the Devonian Period. It was known first by its fronds, and is the first representative of the Archaeopteridales.

Archaeopteryx lithographica Only five specimens of this species, the first bird, are known. *Archaeopteryx* is recorded solely from the Lithographic Limestone of the Solnhofen region of Bavaria, Germany. It was first described by H. von Meyer in 1861 and is of Middle Kimmeridgian or Upper Jurassic age. Recent work on this species by several palaeontologists tends to support the theory that the birds, through *Archaeopteryx*, evolved from coelurosaur dinosaurs similar to *Compsognathus*. The species *A. lithographica* possesses several primitive characters such as teeth, as well as specialized features such as feathers and hollow bones. It is a good example of a connecting species which exhibits a mosaic of evolutionary features.

archegonium Female sex organ of liverworts, mosses, ferns, and most gymnosperms. It is a usually flask-shaped organ, comprising a swollen base or venter containing a single egg-cell (sporophyte), and a slender elongated neck containing one or more layers of cells.

Archelon Probably the largest known sea turtle. *Archelon* is a member of the family Protostegidae and is known only from the Upper Cretaceous.

archenteron Primitive digestive cavity of the embryo at the gastrula stage of development in metazoan animals. It is formed by invagination of mesoderm and endoderm cells, opens to the outside by a blastopore, and finally develops into the gut cavity.

archerfish *See* Toxotidae.

Archilochus (hummingbirds; family Trochilidae) Genus of small hummingbirds with green backs and white under-parts. The males have forked tails, the females have blunt tails with white spots. *A. colubris* (ruby-throated hummingbird) is a long-distance migrant from Canada to Central America. There are two species, both of which breed in N. America and winter in Central America.

Archilochus colubris (ruby-throated hummingbird) *See Archilochus*.

Archinacelloidea (phylum Mollusca, class Monoplacophora) Extinct order of monoplacophorans in which the shells vary from being quite flat to almost horn-shaped. Ornamentation is simple or lacking. The shell interior has only a single pair of muscle scars. The order ranges in age from Upper Cambrian to Lower Silurian.

archipelago Group of islands; a sea containing many scattered small islands.

archipterygium In some fish, a leaf-shaped, narrow-based, paired fin.

Archontophoenix (family Palmae) Genus of palms, in which the trunk is solitary, and hoop-marked; and the leaves pinnate, with a conspicuous crown-shaft, below which the much-branched pendulous inflorescences appear. There are two species, native to subtropical E. Australia, and widely planted as stately ornamentals. *A. alexandrae* (the king palm) is of very similar general appearance to *Dictyosperma album*.

Archoophora (phylum Platyhelminthes, class Turbellaria) Subclass of entirely marine, platyhelminth worms, which comprises the two orders Acoela and Polycladida.

Archosauria Diapsid reptiles, including the crocodiles, dinosaurs, pterosaurs, and thecodontians. Thecodontians were ancestral to the other groups and appeared at the base of the Triassic. The term 'archosaur' means 'ruling reptile'.

Arcoida (phylum Mollusca, class Pelecypoda) Order of sedentary, epifaunal pelecypods in which the adults are byssate or free-living. Typically they are isomyarian, taxodont, and equivalved. The shells are normally trapezoid, and composed of crossed-lamellar calcium carbonate. They have filibranchiate gills, and flat, cardinal areas on the dorsal margin. They first appeared in the Lower Ordovician.

Arctia caja (garden tiger moth) *See* Arctiidae.

arctic air Very cold air mass, generally formed north of the Arctic Circle. As air from this source moves southwards, it cools the regions in which it arrives; but being itself heated in the process it becomes convectively unstable. Polar lows sometimes form and the accompanying wintry precipitation is often heavy. *See also* air mass.

arctic-alpine species Species found both in the arctic and on the higher mountains in the temperate zone. Examples include *Salix herbacea* (least willow) and *Saxifraga oppositifolia* (opposite-leaved saxifrage). Although characteristic of the arctic region and the Alps, Rockies, and Himalayas, they also occur in upland areas between the mountain ranges and the arctic, and represent relics of the late Pleistocene tundra.

arctic and subarctic floristic region Part of Good's (1974) Boreal kingdom, corresponding to the treeless wastes north of the boreal conifer zone. There are virtually no endemic genera, which

suggest that this is possibly the youngest flora in the world. The flora has two components: one arctic, and which includes the endemic species; the other arctic-alpine.

arctic fox (*Alopex lagopus*) *See* Canidae.

arctic front Frontal boundary between cold, arctic air and warmer air masses, usually lying to the south of it. Many depressions originate on it. In NW Canada in winter, for example, the frontal zone incorporates cold, dry, continental polar air and modified maritime arctic air from the Gulf of Alaska.

arctic heath Arctic heath is found in the low- and middle-arctic belts of the tundra. Normally it is dominated by members of the heath family (Ericaceae) or by heath-like plants, e.g. *Vaccinium vitisideae* (crowberry). Arctic heaths tend to be restricted to relatively well-drained sites that are sheltered and snow-covered in winter.

Arctic Ocean Smallest and shallowest of the major oceanic areas, the shallowness being caused by the surrounding wide continental shelves (up to 1700 km wide). For much of the year the surface is covered by floating polar pack ice to a depth of 3–4 m.

arctic scrub Scrub composed of plants that average about 60 cm high, and including dwarf willows, birches, or both. It occurs in damp hollows and along the edge of water in the low-arctic belt of the tundra. Northwards it becomes more stunted and limited in area, and more or less disappears beyond the centre of the middle-arctic belt.

arctic sea smoke (frost smoke) Fog appearing in very cold air from the arctic-ice or frozen-land regions, when it comes over the warmer water of open parts of the Arctic Ocean. The rapid heating induces convection currents which rise in the air: these carry moisture upwards from the water surface, and this becomes visible as the moisture quickly condenses again in the very cold surrounding air. Thus a fog of rising columns of condensing water vapour is formed. The fog is usually fairly shallow, wispy, and smoke-like. This, and its common occurrence in coastal seas around cold land masses (e.g. Labrador, Greenland, and Norway), gave rise to the name. Similar steam fogs may be seen in winter over the open water of rivers when the air is 10 °C or more colder than the water.

Arctiidae (tiger moths, ermines, footmen, tussocks, woolly bears; order Lepidoptera) Family of small to medium-sized moths, many of which are brightly coloured; and which are often distasteful to predators. The larvae are often hairy (and so called 'woolly bears'), and hairs are used to construct the cocoon. *Arctia caja* (garden tiger moth) is widespread in Europe as far north as Lapland. There are about 10 000 species. The family has a worldwide distribution.

Arctocyonidae (superorder Protoungulata, order Condylarthra) Extinct family of unspecialized primitive placental mammals with more than 20 genera, which lived from the Cretaceous to the Eocene but which were most abundant in the Palaeocene. Some were the size of modern bears, and were probably omnivorous; others were smaller and herbivorous. The body was slim, the limbs slender, the feet clawed. The braincase was small, and the teeth primitive, with moderately sharp cusps. *Protoungulatum* of the N. American Upper Cretaceous is the oldest known ungulate.

Arctogea Traditional zoogeographical region comprising the northern continents, Africa, and Indochina, and usually subdivided into the Palaearctic region, the Nearctic region (together the Holarctic region), the Ethiopian region, and the Oriental region. *Compare* Neogea; Notogea; *see also* faunal region.

arcuate Curved or arched.

arcus From the Latin *arcus*, meaning 'arch', a cloud feature having a rolled appearance, with fragmented edges on the leading surface of cumulonimbus and occasionally cumulus. When well developed, the feature has a prominent arch-like form. *See also* cloud classification.

Ardea (herons; family Ardeidae) Genus of large, typical herons, long-necked and long-legged. They feed on aquatic animal life, from fish to small crustacea, and nest colonially in trees and reed-beds. There are 11 species, with cosmopolitan distribution. *A. herodias* (great blue heron) has an all-white colour phase.

Ardea herodias (great blue heron) *See Ardea*.

Ardeidae (herons, bitterns; order Ciconiiformes) Family of long-legged, long-necked, wading birds with spear-like bills. They have long toes, the middle toe being pectinate. Many have long, plumed feathers, and all have powder-down patches. They take a variety of animal food, especially fish. They nest in trees or reed-beds. There are 17 genera, with 61 species, and they are found in marshy areas and on shores, with cosmopolitan distribution. *Cochlearius cochlearius* (boat-billed heron) is often placed in its own family, Cochleariidae. *See also* primaries.

Ardeosaurus brevipes One of the earliest geckos, known only from the Upper Jurassic of Europe.

area-effect speciation Speciation by increased differentiation of two subspecies with incompatible gene-complexes, so that hybrids are strongly selected against.

Areca (family Palmae) Genus of palms, which grow solitarily, or in small clumps. The leaves are pinnate, with a conspicuous crown-shaft. Inflorescences occur distally with only male flowers, and near the base triads a big female is flanked by two males. The fruits have a fleshy mesocarp. The betel-nut comes from *A. catechu*. There are about 50 species, native to tropical Asia.

arenaceous Sandy, or sand-like in appearance or texture. The term is applied to clastic sedimentary rocks with a grain size 0.0625–2.00 mm. Three main groups of arenaceous rocks are recognized: quartz sandstones (quartzites), which contain 95% quartz; arkoses, which have greater than 25% feldspar; and greywackes, which essentially are

poorly sorted sediments with rock (lithic) fragments in a mud matrix. *See also* arkose.

Arenaria **1** (family Caryophyllaceae) Genus of low herbs or dwarf shrubs which have slender shoots, tiny, opposite leaves, and small, usually white flowers with five undivided petals, ten stamens, and three styles (rarely more). The fruit is a tiny capsule, usually six-toothed on opening. Several mat-forming species are cultivated as rock-garden plants (sandworts). There are about 160 species, cosmopolitan in distribution, but most common in the northern temperate zone to the arctic. **2** (turnstones; family Charadriidae) Genus of shore birds including *A. interpres* (turnstone), which breeds in the artic and migrates to the S. hemisphere in winter. It uses its short black beak to turn over pebbles and molluscs in the search for food.

arenaviruses (Arenaviridae) Group (family) of viruses in which the virions are enveloped, variable in shape, and contain single-stranded RNA. They are found in vertebrates, including rodents. The group includes the causal agent of Lassa fever.

Arenga (family Palmae) Genus of palms found in their native habitat as treelets to stout trees. The leaves are pinnate, with pinnate nervation, the sheath coarsely fibrous. Inflorescences often develop basipetally, paired male flowers falling before the solitary female develops. The fruits have a soft, irritant mesocarp and 1–3 seeds. The sugar palm is *A. pinnata*. There are about 20 species, native from the Himalayas, and found from Hainan to New Guinea.

areolate Divided into small areas (areolae) by cracks or lines.

arête Knife-edged, steep-sided ridge found in upland areas that have been or are being glaciated, and formed by the meeting of adjacent cirque headwalls. It may be diversified by 'gendarmes', or abrupt rock pinnacles that have resisted frost shattering.

argentines (herring smelts) *See* Argentinidae.

Argentinidae (herring smelts, argentines; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of small, marine, large-eyed, silvery fish that are found in coastal areas of the oceans. Preferring deeper water, schools of the Atlantic argentine, *Argentina silus*, can be caught in large numbers and then used for fishmeal. There are about 12 species.

argentite (acanthite, silver glance) Mineral, specific gravity 7.2–7.4, hardness 2.0–2.5, chemical composition/Ag_2S. It occurs in hydrothermal veins in association with native silver and as a weathering product of primary silver sulphides. Its distinguishing features are its high specific gravity, colour, and sectility (the ease with which it can be cut with a knife). It is black and opaque, has a slimy black streak, and has a metallic lustre. It crystallizes in the cubic system. The crystals are commonly cubes or octahedra, but they can also be massive. It is an ore mineral for silver.

argillaceous Applied to rocks which are silt-clay-sized sediments with grains less than 0.0625 mm in diameter. They account for more than 50% of sedimentary rocks and most have a very high clay mineral content. Many contain a high percentage of organic material and can be regarded as potential source rocks for hydrocarbons.

argillans *See* cutan.

argillic horizon Sub-surface B soil horizon that is identified by the illuvial accumulation of silicate clays. The amount of clay necessary is defined in comparison with the quantity in the overlying eluvial horizon, but is at least 20% more. Cutans or clay skins may be used to help identify an argillic horizon. It is at least one-tenth as thick as overlying horizons.

arginine Aliphatic, basic, polar amino acid, containing the guanido group.

Argiopidae The now suppressed familial name for orb-web spiders. *See* Araneidae.

argon 40 *See* potassium–argon method.

Argyroneta aquatica (water spider; suborder Araneomorphae, family Agelenidae) The only species of spider to live permanently below water, where it constructs an inverted retreat filled with air carried from the surface by means of its rear legs. The carapace is pale to dark yellowish-brown, with darker striations, and the abdomen, which has a grey pubescence, is covered with an air film, giving a silvery appearance. Females are 8–15 mm long, and males 9–12 mm. The spiders feed mostly on isopods, which are consumed within the air bell. Special bells are made for the sperm web and eggs, and the adults overwinter in the bell, which is specially strengthened. The hatchlings remain within the retreat until after the fourth moult, when they are well covered with pubescence. In humans, the bite of *Argyroneta* can cause itching, shivering, vomiting, and a slight fever lasting 2–3 days. The species is widespread in the Palaearctic region.

Argyropelecus lychnus (silvery hatchetfish) *See* Sternoptychidae.

Argyrosomus regius (meagre) *See* Sciaenidae.

Arhynchodina (order Thigmotrichida) Suborder of ciliate protozoa in which the cytostome is situated toward the posterior end of the cell. Body cilia are usually uniform in arrangement. They are parasites or commensals in aquatic molluscs.

Aridisol Mineral soil profile, an order of the USDA Soil Taxonomy, found in arid environments. These soils have very little organic matter in their surface horizons, but may contain calcium carbonate or gypsum, and/or soluble-salt accumulations.

aridity index Indication of moisture deficit. All climatic classifications include arid categories, defined either by quantitative or, more usually, by mainly subjective criteria. C. W. Thornthwaite first used the term 'aridity index' and calculated it as 100 × (the water deficit / the potential evaporation). *See also* radiation index of dryness; and Thornthwaite climate classification.

Ariidae (Tachysuridae; sea catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of mainly marine catfish with a forked tail-fin, adipose dorsal fin, naked skin, and several pairs of barbels around the mouth. They are found in tropical and subtropical seas around the world. Many species, including the gaff-topsail catfish, *Bagre marinus*, carry out oral incubation, with the males incubating fertilized eggs in the mouth for up to six weeks. There are many species. *See also* buccal incubation.

aril Usually fleshy, and often brightly coloured outgrowth from the funicle or hilum of a seed, a third integument. Arils probably often aid seed dispersal, by drawing attention to the seed after the fruit has dehisced, and by providing food as an attractant and reward to the disperser.

arillate Possessing an aril, a diagnostic characteristic of the seeds of some flowering plants, especially tropical trees.

arista Bristle-like extension of the third antennal segment in the dipteran suborders Brachycera and Cyclorrapha. The 'bristle' is borne dorsally and may be visibly segmented, with or without pubescence or cilia.

aristogenesis Theory, like those of entelechy, nomogenesis, and orthogensis, that claims that evolution proceeds along a determined path. Today, however, most people accept that natural selection does not direct evolution towards any particular kind of organism or physiological attribute, and that there is no mysterious inner guiding force either.

Aristolochiaceae (birthworts) Family of climbers, and a few herbs. The flowers are usually zygomorphic, often foetid; have a calyx that is often enlarged and highly coloured; no corolla; six to many stamens; and the ovary inferior and 4–6-locular. The capsule contains many small seeds. The roots are often medicinal. *Aristolochia* is Dutchman's pipe. There are seven genera, with about 625 species, of warm-temperate to tropical distribution.

Arixeniidae (class Insecta, order Dermaptera) Family of earwigs which are hairy, wingless, and robust, with short, rod-like forceps. Only two species are known, and they are associated with two species of bats found in Malaysia, Indonesia, and the Philippines.

arkose Arenaceous rock containing quartz and 25% or more of feldspar. The feldspar is easily destroyed during transportation or chemical change, and the implication is that arkoses were deposited rapidly under fairly arid environmental conditions. Most were also deposited near to land and probably in close proximity to a granitic area. *See* arenaceous.

Armadillidae (pill bugs; subclass Malacostraca, order Isopoda) Family of terrestrial pill bugs which have five pairs of tracheal gills and lack a water-transport system. All members of the family can roll up completely in response to disturbance or in the presence of predators.

Armadillidium vulgare (pill bug; subclass Malacostraca, order Isopoda) Widely distributed and abundant species of isopod which has a rectangular to ovoid shape. Individuals may be coloured grey, black, or pale yellow, and can roll up completely when disturbed, assuming a spherical appearance. They may be up to 6 mm in diameter when rolled up, and are found on the upper shore, beneath stones. Parthenogenetic females may occur in bisexual races.

armadillos *See* Dasypodoidea.

Armillaria (family Tricholomataceae) Genus of fungi in which the fruit bodies are mushroom-shaped, and produce white spores. It includes *A. mellea* (honey fungus), a destructive parasite of trees, shrubs, and other plants. *A. mellea* can spread from one host plant to another by means of rhizomorphs. It can also live saprotrophically, e.g. on dead tree-stumps.

armoured catfish *See* Callichthyidae; and Loricariidae.

army ant *See* Dorylinae.

army worms *See* Noctuidae; and Sciaridae.

Arnold's lyretail (*Aphyosemion arnoldi*) *See* annual fish; and Cyprinodontidae.

arolium Median pad found between the tarsal claws of an insect.

Aromadendron (family Magnoliaceae) Genus of tropical rainforest trees, which are sometimes huge, growing to 60 m. The fruiting carpels are indehiscent, and concrescent as a fleshy syncarp. There are four species, occurring in Malaya, Sumatra, Java, and Borneo.

Aromia moschata (musk beetle) *See* Cerambycidae.

Arothron stellatus (starry pufferfish) *See* Tetraodontidae.

arousal 1 Transition from the sleeping to the waking state. 2 Increase in the responsiveness of an animal to sensory stimuli.

arrhenotoky Production of males from unfertilized eggs, a phenomenon characteristic of all Hymenoptera (sawflies, wasps, ants, and bees).

Arripidae (Australian salmon; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family confined to the temperate waters of Australia and New Zealand, comprising two species of fish which are often abundant along the coastal areas, and of considerable economic importance. The Australian salmon, *Arripis trutta* (not related to the true salmon), is a large carnivorous fish, often exceeding 5 kg in weight. It is highly regarded as a sporting fish, but commercial catches usually go to canneries.

arrow-grass (*Triglochin*) *See* Juncaginaceae.

arrowpoison frogs *See Dendrobates*.

arrowroot *See Maranta*; and *Tacca*.

arrowtooth eels *See* Dysommidae.

arrow worms *See* Chaetognatha.

arroyo Gully found in an arid or semi-arid region and possessing steep or vertical walls cut in fine-grained cohesive sediments. The floor is flat and usually sandy. Found especially in the SW United States, parts of India, S. Africa, and around the Mediterranean.

arsenopyrite (mispickel) Mineral, specific gravity 5.9–6.2, hardness 5.5–6.0, chemical composition FeAsS. It occurs in high- to moderate-temperature mineral veins in association with gold, ores of tin, tungsten, galena, and quartz. It also occurs disseminated in limestones, dolomites, gneisses, and pegmatites. Its distinguishing features are its colour and crystal form. Its colour is silver-grey to white, often with a tarnish, with a dark greyish or black streak, and a metallic lustre. It crystallizes in the monoclinic system. The crystals are prismatic, often striated, and also massive and granular. It is the principal source of arsenic compounds for pest control, and is used in the manufacture of dyes and chemicals, and in leather treatment.

Artamidae (wood-swallows; order Passeriformes) Family of smallish, brown or grey birds with black and white markings and long, pointed wings. They are the only passerines with powder-down feathers. They are highly social; and insectivorous, mainly aerial feeders. They inhabit clearings and open country near water, nesting on ledges or in trees. There is one genus (*Artamus*) containing 10 species, found in India, S. China, SE Asia, Australasia, and some S. Pacific islands.

Artamus (wood-swallows) *See* Artamidae.

artefact (artifact) **1** Man-made object. **2** Something observed that is not naturally present but that has arisen as a result of the process of observation or investigation.

Artemisia (family Compositae) Genus of perennial (or, rarely, annual) herbs or low shrubs, often aromatic, with leaves that are alternate, and much divided pinnately into narrow segments. The flower heads are tiny, usually numerous, often woolly, and gathered into racemes or panicles. The receptacle is flat, and naked; all the florets are tubular, surrounded by overlapping, scarious-edged bracts. There is no pappus. The genus includes mugworts, and wormwoods. Wormwood (*A. absinthum*) is used for flavouring beers and other drinks. There are about 200 species, occurring mostly in dry grasslands of the northern temperate semi-arid, and arctic zones.

Artemisia absinthum (wormwood) *See Artemisia*.

artery Blood vessel conveying blood away from the heart.

artesian water Ground water that originally is confined in an aquifer and that reaches the land surface due to the high hydraulic pressure that may be developed in a confined aquifer when this has a synclinal form. The London Basin, England, provided artesian water during the nineteenth century from a chalk aquifer sealed by clays.

Arthrobacter Genus of bacteria of uncertain taxonomic position. The cells undergo a change in form during culture in the laboratory, from roughly spherical to irregularly rod-shaped. They are chemo-organotrophic, and can grow only in the presence of air. They are found chiefly in soil.

Arthrochirotida (class Holothuroidea) Extinct order of sea-cucumbers known with certainty only from the Devonian. Characterized by an articulated axial skeleton of stout sclerites in the tentacles.

arthrodial membrane *See* exoskeleton.

Arthrodira (Arthrodiriformes; class Placodermi) Group or order of fossil (Devonian) fish with a body covered with bony plates, including a heavily armoured head shield, the gills opening between head and body armour.

Arthropleona *See* Collembola.

Arthropoda Highly diverse phylum of jointed-limbed animals, which includes the crustaceans, arachnids, and insects, as the major components, as well as the classes Symphyla, Pauropoda, Chilopoda (centipedes), Diplopoda (millipedes), and the extinct trilobites and eurypterids, which lived from the middle Ordovician to the Permian. When they appear first in the Cambrian they are already well diversified, with such forms as the trilobites, trilobitoids, ostracodes, and crabs present. This implies an earlier, hidden history, reaching back into the Precambrian. The Arthropoda comprise more than 75% of all animal species that have been described. Embryological evidence shows that they are derived either from primitive polychaete worms, or from ancestors common to both. Arthropods share with annelid worms a metamerically segmented body, at least in the embryo, a dorsal heart, a dorsal anterior brain, and a ventral nerve cord that has segmental, ganglionic swellings. The limbs of all arthropods are paired, jointed, and segmental, and the body has a chitinous exoskeleton or cuticle. Primitively, the limbs and cuticular plates correspond to the metameric segmentation of the body, but in many groups there is considerable loss and/or fusion of segments. A growing body of evidence from embryology and comparative morphology suggests that 'arthropodization', (i.e. a chitinous exoskeleton and jointed limbs), arose independently three or four times from annelid or proto-annelid stock. This makes the Arthropoda a polyphyletic group, and it is probably best regarded as a superphylum. Several component groups should then be raised to phylum status, so that a provisional classification embodying these changes would be this: superphylum Arthropoda (jointed-limbed, invertebrate animals with a chitinous exoskeleton); phylum Trilobita (the fossil trilobites); phylum Chelicerata (arthropods lacking antennae and in which the first post-oral appendages are feeding structures, called 'chelicerae'), class Merostomata (fossil eurypterids and living horseshoe and king crabs), class Arachnida (scorpions, harvestmen, spiders, ticks, and mites), class Pycnogonida (sea spiders), grade Mandibulata (arthropods with antennae and in which the first post-oral appendages are mandibles); phylum Crustacea (mandibulate arthropods of marine origin, with two pairs of antennae, and

biramous limbs: the crabs, lobsters, shrimps, barnacles, and woodlice); and phylum Uniramia (mandibulate arthropods of terrestrial origin with a single pair of antennae and uniramous limbs), class Onychophora (onycophorans), class Pauropoda (pauropodans), class Diplopoda (millipedes), class Symphyla (symphylans), class Chilopoda (centipedes), and class Insecta (insects).

arthrospore Type of fungal spore formed as a result of the fragmentation of a hypha.

artichoke gall *See* Cynipinae.

articulamentum Middle layer of calcareous shell material possessed by the polyplacophoran molluscs. It is generally a hard layer that extends forward to form insertion plates between the valves.

articular bone In all Gnathostomata except Mammalia, the bone of the lower jaw that articulates with the upper jaw. In Mammalia the articular has become the malleus of the middle ear.

Articulata 1 (phylum Brachiopoda) Class of brachiopods, with calcareous valves which are impunctate, punctate, or pseudopunctate. The fibrous or prismatic secondary layer and non-fibrous primary layer are well differentiated. The periostracum is of protein. Hinge teeth and dental sockets are developed. Lophophore support is formed from modifications of socket ridges to give crura, loops, or spires. The alimentary canal ends blindly. They first appeared in the Lower Cambrian. There are six orders, with 37 superfamilies. 2 (sea-lilies; subphylum Crinozoa, class Crinoidea) Subclass of sea-lilies (crinoids) in which the basal plates are small or strongly reduced. Articulation between the radial and brachials, and in the majority of brachials, is muscular, with a well developed fulcral ridge. The arms are always uniserial. All post-Palaeozoic crinoids belong to the Articulata.

artifact *See* artefact.

artificial In ecology, applied to a community, or habitat, or both that have been changed drastically from their original condition by human activity so that they are completely different from and unrelated to the community or habitat originally present at the site. Examples include the Norfolk Broads (England), formed by the natural flooding of medieval peat cuttings; man-made reservoirs; and the reclamation of land from the sea, as in the polderlands of Holland.

artificial propagation of fish Type of fish culture for stocking purposes. It involves 'stripping' eggs of ripe female fish followed by mixing with milt from mature males. The fertilized eggs are then either distributed at once or incubated and hatched in special receptacles before distribution to waters that have to be stocked. Increasing numbers of fish species are being propagated in this way.

artificial rain Rain, or increased rain, produced by seeding clouds artificially with 'dry ice' (frozen carbon dioxide), silver iodide, or other appropriate particles, which act as condensation nuclei.

artificial reef Man-made structure placed on the bottom of a river or a coastal region to increase the local population of fish for the benefit of fishermen. Such reefs can be constructed from rocks, used cars or car tyres, hollow concrete blocks, etc. Marine plants and encrusting animals will settle on the surface, in turn attracting fish searching for food or shelter.

artificial selection Selection by humans of individual plants or animals from which to breed the next generation, because these possess the most marked development of the required attributes. Typically the process is repeated in successive generations until those attributes are fixed in the descendent offspring. Such artificial selection can result in dramatic changes, such as took place in the domestication of plants and animals from their wild forebears.

Artiodactyla (cohort Ferungulata, superorder Paraxonia) Even-toed ungulates, an order of mammals that includes the camels, pigs, and ruminants, together with numerous extinct varieties. They are the most successful of the hoofed animals. They are descended from the Condylarthra, and underwent a spectacular burst of adaptive radiation in Eocene and early Oligocene times. They are terrestrial or amphibious herbivorous mammals. Except for the camels the gait is unguligrade (limbs are moved as a whole by the action of shoulder and hip muscles). The axis of the foot is paraxonic (passing between third and fourth digits); the first digit is absent, the second and fifth often reduced or lost. The digits terminate in hoofs, the third and fourth of equal size, usually flattened on the inner and ventral surfaces. The dentition is specialized; the upper incisors are lost in some species, the lower incisors biting against the hardened gum of the premaxilla; the canines may form tusks; the premolars are not molarized, elongated hypsodont molars providing grinding surfaces, the four cusps often being developed into longitudinal ridges. The tongue is large, mobile, protrusible, pointed, and the papillae are often horny. The stomach is elaborate. The brain is moderately well developed in later forms, although the cerebral hemispheres only partly cover the cerebellum, and in early and some modern forms (e.g. hippopotamus and pig) the brain is small. Where present, horns have a bony core, and are not shed. The olfactory sense is important. Visual, auditory, olfactory, and tactile signals are important in communication.

Artocarpus (family Moraceae) Genus of small to medium trees, yielding latex from the bark, and useful timber. The leaves have big stipules, commonly divided. Male flowers are borne in catkins, female flowers in heads. The fruit is multiple, formed on the fleshy receptacle by concrescent achenes surrounded by a fleshy perianth, often cauliflorous, and gigantic, in *A. integrifolia* (jak or jackfruit) attaining 1 × 0.6 m. The fruit of *A. altilis* (breadfruit) is starchy, and bread-like when roasted. There are 47 species, occurring in tropical SE Asia.

Arundo (family Gramineae) Genus of reeds. *A. donax* may attain 7 m and is utilized for baskets, etc., and formerly for arrow shafts. It is good for making paper. Gardeners' garters is a variegated

horticultural variety. There are 12 species, found in tropical and temperate regions, mainly in the northern hemisphere.

Ascaphidae (tailed frogs; class Amphibia, order Anura (Salientia), suborder Amphicoela) Family of amphibians that, like leiopelmatids (*see* Leiopelmatidae), have nine amphicoelous vertebrae, and free ribs. A muscular extension of the cloaca ('tail') is used in copulation. Tadpoles cling to rocks with a sucking mouth. There is a single species (*Ascaphus truei*), found in mountain streams in western N. America.

Ascension and St Helena floral region Part of Good's (1974) Palaeotropical kingdom, within the African subkingdom, comprising just two islands. This is probably the smallest floral region. There are five endemic genera, three of them being woody members of the Compositae. The proportion of endemism at the species level was very high, but much of this distinctive native flora has been exterminated by domesticated animals.

Aschelminthes Phylum of worms that are typified by possessing a pseudocoelom. True segmentation is not present. The intestine is straight. There are five classes. Some are free-living, and some are parasites.

asci Plural of ascus.

Asclepiadaceae Family of erect or twining shrubs or perennial herbs, sometimes fleshy, and usually with white sap. Leaves are opposite, or whorled. Inflorescences are cymose. The flowers are regular, and pentamerous; the petals contorted, stamens often with two pollinia, the ovary semi-inferior. The fruit consists of paired follicles. The seeds are tiny, and plumed. There are about 130 genera, with 2000 species, mainly of the tropics and subtropics, especially of S. America.

Asclepias (milkweeds; family Asclepiadaceae) Genus of 120 species of herbs, occurring in America.

ascocarp Fruit body of an ascomycete within which asci and ascospores are formed.

Ascoceratida (class Cephalopoda, subclass Nautiloidea) Order of orthoconic and cyrtoconic cephalopods that have a thin juvenile portion and an inflated adult portion to the test. The siphuncle is near-central. Siphuncular and cameral deposits are not found. The order contains only 13 genera, and all are uncommon fossils. They range in age from Middle Ordovician to Upper Silurian.

Ascoglossa *See* Sacoglossa.

ascogonium Female sex organ formed by certain fungi of the subdivision Ascomycotina.

ascolichen Any lichen in which the mycobiont is an ascomycete.

ascomycete Fungus of the subdivision Ascomycotina.

Ascomycotina (division Eumycota) Subdivision of fungi in which sexually produced spores are contained within asci and are called ascospores. There are six classes, including about 15 000 species. They are saprotrophic or parasitic. Some species can cause disease in animals or plants. They are found in a wide range of habitats.

ascon Body structure of a poriferan (sponge), if it consists of one, rather large chamber.

Ascophora (class Gymnolaemata, order Cheilostomata) Suborder of cheilostome bryozoans in which the tentacles are protruded and withdrawn by means of a hydrostatic organ called a 'compensation sac'. The operculum is hinged in such a way that it controls the flow of water into the interior. The suborder occurs from the Cretaceous to Recent.

Ascophyllum (family Fucaceae, order Fucales) Genus of brown seaweeds which resemble *Fucus*, but which can be distinguished by the absence of a midrib. The thallus is typically flattened and strap-like, and air bladders are usually present; it may reach several metres in length. Spores develop in yellowish receptacles, resembling sultanas, borne on short stalks arising from either side of the fronds. The only British species is *A. nodosum*. *See* egg wrack.

ascorbic acid The water-soluble vitamin C that occurs in large quantities in fruit and vegetables, a deficiency of which causes scurvy.

ascospore Sexually produced spore formed within an ascus by fungi of the subdivision Ascomycotina.

ascostroma Type of fungal fruit body in which asci develop on or within a stroma.

ascus Minute, bag-like structure within which ascospores develop in fungi of the Ascomycotina. An ascus often contains eight ascospores which, in many species, are discharged explosively.

aseismic ridge Long, linear, inactive, volcanic, topographic feature found in many deep-ocean basins. An example is the Walvis Ridge in the SE Atlantic which extends for 3000 km and in places reaches a height of 2 km above the deep-ocean floor.

aseptate Lacking partitions or septa.

aseptic meningitis Form of meningitis in which there is an increase in the number of lymphocytes in the cerebrospinal fluid. Usually it is caused by one of several types of virus, although bacterial causal agents are also known.

asexual generation *See* agamic generation.

asexual reproduction Reproduction without the sexual processes of gamete formation. In plants it consists of vegetative reproduction, apospory, and apogamy. Asexual reproduction occurs by fission in many protozoan animals but also in some multicellular ones (e.g. corals); and by budding (gemmation) in many liverworts, mosses, coelenterates, and ascidians. *See also* apomixis.

ash 1 Tephra less than 4 mm in size. *See* volcano. 2 (tree, *Fraxinus*) *See* Oleaceae.

Asian land salamanders *See* Hynobiidae.

Asilidae (assassin flies, robber flies; class Insecta, order Diptera, suborder Brachycera) Family of

medium to large, elongate, bristly flies, which have a horny proboscis adapted for piercing. The wing vein R_1 is very long, and M_1 terminates some distance beyond the apex of the wing. The legs are powerful and flexible, with large pulvilli, and a bristle-like empodium. A prominent tuft of hairs, or 'beard', and protruding eyes are also characteristic of the asilids. Virtually all adults are predators of other insects, using their long legs to grasp and carry off prey. The proboscis is sharp, points forward, and is used to pierce the prey and suck it dry. It can easily enter the hardest of cuticles, and in certain cases may inject venom. Asilid larvae are either predacious or scavengers in soil, leaf-litter, or other ground substrates. Larvae are amphineustic, and their mouthparts comprise a hook-shaped labrum, sharp mandibles, and broad maxillae with two-segmented palps. The Asilidae is the largest family within its suborder, with at least 4000 described species. *See also* venation.

Asio (owls; family Strigidae) Genus of medium-sized, 'eared' owls, having on the crown two feather tufts which can be raised. They feed on birds and mammals, *A. flammeus* (short-eared owl) feeding mainly diurnally. They nest on the ground or in trees. There are six species, found in N., C., and S. America, Africa, Europe, and N. Asia.

Asio flammeus (short-eared owl) *See Asio.*

asities (*Philepitta*) *See* Philepittidae.

asoka *Saraca asoca*, a sacred Indian tree. *See Saraca.*

asp *See Vipera aspis.*

Asparagus (family Liliaceae) Genus of small shrubs or perennial herbs with creeping underground stems, and green, needle-like branchlets replacing the leaves, which are reduced to papery scales. *A. officinalis* is cultivated for its edible young shoots, which are then forced and blanched. *A. plumosus* produces attractive, feathery foliage used in flower bouquets. There are about 300 species found throughout the Old World.

aspartic acid An aliphatic, acidic, polar alpha-amino acid.

aspen (*Populus tremula*) *See Populus.*

aspergillosis General term for any human or animal disease caused by a fungus of the genus *Aspergillus*. In humans the most common form of the disease is a lung infection which may lead to pneumonia; the disease is uncommon.

Aspergillus (class Hyphomycetes) Form-genus of fungi in which conidia develop within phialids. Some species have perfect states classified in the Eurotiales. They are saprotrophic, but some can also cause disease in humans.

asphaltite *See* gilsonite.

aspic viper *See Vipera aspis.*

Aspidochiratacea (class Holothuroidea) Subclass of sea-cucumbers with 10–30 shield-shaped tentacles which spoon organic debris from the sea-floor into the mouth. There are no pharyngeal retractor muscles. The test is vestigial, consisting of scattered spicules in the dermis. They first appeared in the Carboniferous.

Aspidochirotida (subclass Aspidochirotacea) Order of holothuroids with large, branched respiratory trees.

Aspidogastraea *See* Aspidogastrea.

Aspidogastrea (Aspidogastraea; phylum Platyhelminthes) Class, or in some classifications an order of Trematoda, of parasitic, platyhelminth worms in which the gut, pharynx, intestine, and ventral sucker are present and the anterior sucker absent. Mature individuals also lack cilia. All are endoparasitic, and development may involve one or two hosts.

Aspleniaceae Family of ferns, distinguished among the advanced (leptosporangiate) ferns by its oblong or linear superficial sori, borne along one or both sides of the veins; the indusium is often much elongated, sometimes double, or absent. There are nearly 100 genera, of cosmopolitan distribution.

Asplenium (spleenworts; family Aspleniaceae) Cosmopolitan genus of some hundreds of species of ferns with firm scales on the rhizome, but leaves which are not densely scaly below. Leaf veins are usually free; the sori oval to linear, usually separate and simple, with the indusium opening towards the midrib.

asporogenous Does not produce spores.

Aspredinidae (banjo catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of mainly small freshwater catfish whose common name is derived from the peculiar shape of the flat, triangular head region, and the long tail. In some species the female takes care of the fertilized eggs by carrying them along in a modified region of the skin of the belly. There are about 50 species, found in S. America.

asp viper *See Vipera aspis.*

ass (*Equus*) *See* Equidae.

assai *See Euterpe.*

assart 1 Grub up the trees and underwood of forest land in order to convert the area to arable or pasture use. 2 Land cleared in this way. 3 Private farmland formed by the clearance of part of a wood, common, or forest.

assassin bug General name for bugs of the family Reduviidae, but in Britain usually restricted to *Reduvius personatus*, which lives in unheated buildings, and preys on small arthropods. The immature stages mask themselves with a covering of debris.

assassin flies *See* Asilidae.

assemblage Collection of plants and/or animals characteristically associated with a particular environment. They can be used as an indicator of that environment, e.g. in geobotanical exploration.

assemblage zone (coenozone, faunizone) Stratigraphic unit or level of strata characterized by an assemblage of animals and/or plants.

assimilate The portion of the food energy consumed by an organism that is metabolized by that organism. Some food, or in the case of a plant some light energy, may pass through the organism without being used.

assimilation Synthesis of protoplasm and other complex substances from simpler molecules produced from food by digestion and absorbed into the living cells of an organism.

association 1 In ethology, a learned connection between a type of event and a neutral stimulus that precedes it, e.g. the sensation of hunger that may follow the chiming of a clock, denoting the time at which a meal is customarily presented. *See also* conditioning. 2 *See* plant association.

association analysis Hierarchical method of classification which is divisive and monothetic. Association analysis uses χ^2 as a measure of association between pairs of species (attributes) found at a range of sample sites (individuals). The species or attribute with the highest overall sum of χ^2 values (i.e. the strongest links) with all other species is selected as the basis for subdivision into two groups of sites or of individuals, either having or lacking that attribute. The process is then repeated for each new group until no further subdivision is required.

association measure Any measure of the link between two variables as shown by quantitative or qualitative data describing their characteristics. Links between continuous variables—e.g. mass and height, or crop yield and rainfall—may be assessed statistically using correlation and regression methods. Links between qualitative characteristics—e.g. eye colour and hair colour, or aspect and slope form—may be assessed statistically using contingency tables and tests based on χ^2 or an appropriate non-parametric test. Sometimes continuous variables can be more conveniently tested in qualitative form, e.g. height as short, medium, or tall, especially when the link with some other qualitative variable is wanted, e.g. aspect and tree height.

associes Phytosociological term used in the Clementsian (American) and British traditions and generally implying a sub-climax community in a successional sequence.

assortative mating Sexual reproduction in which the pairing of male and female is not random, but involves a tendency for males of a particular kind to breed with females of a particular kind, or the converse. If the two partners in each pair tend to be more alike than is expected by chance, then it is referred to as positive assortative mating. Assortative mating for some traits is common: examples include positive assortative mating for skin colour and height in humans, and for time of development to sexual maturity in plants and in many insects with one generation per year; and negative assortative mating for different plumage colour-phases in arctic skuas.

Astata *See* Sphecidae.

Aster (family Compositae) Genus of mostly perennial herbs in which the leaves are simple, and spirally arranged; the flower heads have imbricate bracts, and flat, naked receptacles; ray florets, usually present, are white, blue, or red, but never yellow; the disc florets are yellow. The achenes are flattened, and smooth, with a pappus of short, bristly hairs. Many N. American species are cultivated as Michaelmas daisies and have become naturalized in Europe, and elsewhere. There are about 500 species, mostly northern temperate.

aster Group of microtubules radiating out from each centriole pair during cell division in animal cells.

Asteriadina (starfish; subclass Asteroidea, order Forcipulatida) Suborder of starfish (asteroids) in which numerous dorsal (aboral) ossicles form crossed pedicellariae, consisting of a basal ossicle which bears a pincer-like pair of small spines. They first appeared in the Lower Jurassic, and the suborder includes many extant, predatory species.

Asteroidea (starfish; subphylum Asterozoa, class Stelleroidea) Subclass which includes all extant starfish, characterized by the possession of poorly demarcated, broad arms containing a large coelomic cavity. The open ambulacral grooves bear rows of large tube feet which are used especially in feeding and locomotion. Respiration takes place through external gills (papulae) which are restricted to the dorsal surface. They occur from the Ordovician to Recent.

Asterozoa (phylum Echinodermata) Subphylum whose members have radial symmetry of projecting rays, and a star-shaped body. It contains the class Stelleroidea.

Asticcacaulis Genus of Gram-negative bacteria which is not assigned to any taxonomic family. It is similar to *Caulobacter* in its life cycle, but differs in that the stalk occurs eccentrically at one pole or on one side of the cell, and does not function in attachment. Cells adhere to a substrate by adhesive material near one end of the cell. It is found in habitats similar to those of *Caulobacter*.

Astomatida (subclass Holotrichia) Order of ciliate protozoa which have uniformly arranged body cilia, and which appear to lack a cytostome. Most are parasitic in invertebrates, especially in oligochaetes.

astomatous Lacking a mouth, cytostome or stomata.

astragalus (talus) *See* tibiale.

Astrapotheria (cohort Ferungulata, superorder Protungulata) Extinct order of S. American ungulates which appeared during the Eocene and flourished in the absence of herbivore competition or carnivore predation during the Oligocene and Miocene. The skull was short, the upper incisors were lost and the premaxillae much reduced, the lower incisors were present, the upper and lower canines were large and persistently-growing, and the rearmost molars were large. A slit-like nasal opening on top of the skull suggests that astrapotherids—e.g. the Miocene *Astrapotherium*, which was the size of a rhinoceros—had elephant-like probosces. In contrast to the heavily

built front legs, head, neck, and anterior part of the body, the spine, hindquarters, and hind legs were feeble. The feet were small, perhaps resting on pads, but unlike those of any other group. Possibly, therefore, the animals were amphibious.

Astroblepidae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater fish with naked skin, small eyes, and ventrally positioned mouth. There are about 35 species, occurring in S. America.

Astrocoeniina (order Madreporaria) Suborder of colonial corals with small corallites, which appeared first in the Middle Triassic. They are characterized by the possession of septa formed from relatively few (not more than eight) trabeculae, and usually they have no more than two cycles of tentacles arranged in a single ring around the mouth, which leads to a smooth stomodeum. The suborder contains five families, with 46 genera.

Astroloma (family Epacridaceae) Genus of prostrate and low shrubs. They exhibit xeromorphic characteristics, with small leaves, tubular flowers, and fleshy berries. There are approximately 20 species, all endemic to Australia. They are found mainly on open heath and bushland in the south-west.

Astronesthidae (snaggle-tooth; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of small, black, deep-sea fish found in tropical and temperate waters. They have well developed fangs, and a comb-toothed edge on the upper jaw. A distinct barbel is attached to the chin. There are about 27 species.

asymmetric valley Valley that has one side steeper than the other, the opposing sides standing at significantly contrasting angles. This may be due to geological structure, or to variation in the nature and intensity of erosional processes. They are common in past and present periglacial environments, where aspect has a significant effect on the nature of frost-based processes.

atavism The reappearance of a character after several generations, the character being the expression of a recessive gene or of complementary genes. The character, or individual possessing this character, is sometimes referred to as a 'throwback'.

Ateles (spider monkey) *See* Cebidae.

Atelocynus microtis (small-eared dog) *See* Canidae.

Atelopodidae (class Amphibia, order Anura (Salientia), suborder Procoela) Family of small, brightly coloured, often poisonous tree frogs. The Bidder's organ found in males indicates a bufonid relationship. Like toads, most walk rather than hop. There are two genera, with 30 species, found in C. and S. America.

Atelostomata (class Echinoidea) Superorder of irregular echinoids characterized by the lack of compound ambulacral plates, lantern, girdle, or gill slits. The apical system and peristome are rarely opposite, and the interambulacra are wider than the ambulacra on the lower surface. The superorder includes the orders Disasteroida, Holasteroida, and Spatangoida.

Athecata Alternative name for the hydroid suborder Gymnoblastina.

Atherinidae (silversides, sand smelts; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Family of rather small, slender fish, with relatively large eyes, terminal mouth, and two widely separated dorsal fins. Most species occur in schools in inshore seas, with some found in estuaries or freshwater systems. There are more than 150 species. Perhaps the best known species is *Leuresthes tenuis* (California grunion), famous for its communal spawning on sandy shores at high tide at night.

Atheriniformes (class Osteichthyes, subclass Actinopterygii) Order of bony fish, including fairly large marine individuals, e.g. the flying fish and the sauries, as well as many small freshwater species, e.g. killifish, guppy, and mosquitofish. Members of this order have also been placed in other orders, including the Beloniformes, and the Cyprinodontiformes.

Atherosperma (family Monomiaceae) Genus of two species of trees endemic to Tasmania. Formerly they were placed in the family Atherospermataceae.

Atherosperma moschatum (black (southern) sassafras) Conical, evergreen tree up to 20 m tall, with strongly fragrant bark, leaves, and flowers. It is a common species in the rainforests, and on lowlands it may be the dominant species.

athlete's foot In humans, a fungal disease of the foot in which symptoms include the appearance of red, itchy, sometimes cracking lesions between the toes. The disease may be caused by any of several dermatophytes, e.g. *Trichophyton mentagrophytes*.

Athrotaxis (family Taxodiaceae) Genus of conifers, which have small, often scale-like, adpressed or spreading, spirally arranged leaves, and small (to 3 cm long) globose cones; each scale with a curved-out spine at its tip, ripening orange in autumn. They are tall trees, cultivated in some temperate arboreta. There are three species, found in Tasmania.

Athyrium (family Aspleniaceae) Genus of ferns with large, soft rhizome scales, and 1–3 pinnate, soft, hairless fronds; sori are borne on receptacles on a side branch of a vein; indusia are hooked, or crescent-shaped, and toothed, or rarely absent. There are about 180 species. They are cosmopolitan, but most occur in temperate E. Asia.

Atlantic big-eye (*Priacanthus arenatus*) *See* Priacanthidae.

Atlantic boarfish (*Capros aper*) *See* Caproidae.

Atlantic capelin (*Mallotus villosus*) *See* Osmeridae.

Atlantic eagle ray (*Myliobatis aquila*) *See* Myliobatidae.

Atlantic guitarfish (*Rhinobatos rhinobatos*) *See* Rhinobatidae.

Atlantic hagfish (*Myxine glutinosa*) *See* Myxinidae.

Atlantic mackerel (*Scomber scombrus*) *See* Scombridae.

Atlantic North American floral region Part of Good's (1974) Boreal kingdom. It is a large and extensive flora with 100–200 endemic genera. *Robinia* (locust tree) is a well-known example, and there is also *Franklinia*, a garden tree that was obtained from a single plant of a single species, and which is now extinct in the wild. As a whole the flora strongly resembles those of temperate Eurasia, and of China and Japan.

Atlantic nurse shark (*Ginglymostoma cirratum*) *See* Orectolobidae.

Atlantic Ocean One of the main oceanic areas of the world. It is relatively shallow, having an average depth of 3310 m; and it is the warmest (average temperature 3.73 °C), and most saline (average salinity 34.9 parts per thousand) of the major oceans.

Atlantic period Period in post-glacial times (i.e. post-Devensian or Flandrian) from about 7500 BP to 5000 BP which, according to pollen evidence, was warmer than the present, and moist; with oceanic climatic conditions prevailing throughout NW Europe. It corresponds to Pollen Zone VIIa, which throughout NW Europe is characterized by the most thermophilous species found in post-glacial pollen records. The climatic optimum of the post-glacial, or current Flandrian interglacial, is dated to the early Atlantic period. *Compare* Boreal period.

Atlantic pomfret *See* Bramidae.

Atlantic salmon (*Salmo salar*) *See* Salmonidae.

Atlantic saury (*Scomberesox saurus*) *See* Scomberesocidae.

Atlantic scad (*Trachurus trachurus*) *See* Carangidae.

Atlantic torpedo (*Torpedo nobiliana*) *See* Torpedinidae.

Atlantic tuna (*Thunnis thynnus*) *See* Scombridae.

Atlantic velvet-belly (*Etmopterus spinax*) *See* Squalidae.

Atlantic winter flounder (*Pseudopleuronectes americanus*) *See* Pleuronectidae.

Atlapetes (brush-finches; family Emberizidae) Genus of large, stout, predominantly olive-grey finches. They are mainly skulking, foraging on or near the ground, and are usually found singly or in pairs in the undergrowth of highland rain and cloud forests. There are about 25 species, found in C. and S. America.

atlas moths *See* Saturniidae.

atlas vertebra The first neck vertebra, which articulates with the occipital region of the skull.

atmosphere 1 Air surrounding the Earth. The atmosphere has no precise upper limit, but for all practical purposes the absolute top can be regarded as being at about 200 km. The density of the atmosphere decreases rapidly with height, and about three-quarters of the mass of the atmosphere is contained within the lowest major layer, the troposphere, whose depth varies between about 10 km and 17 km, being generally smaller further from the equator. 2 Unit of pressure. Its value is approximately the average pressure of the atmosphere at sea-level, the figure adopted being the pressure at sea-level in the International Standard Atmosphere (760 mm of mercury, or 1013.25 mb). *See also* atmospheric structure.

atmospheric boil *See* shimmer.

atmospheric pollution Solid and gaseous contaminants in the atmosphere which occur as dust, smoke, or sulphur dioxide and other gases, particularly from the combustion of fossil fuels and certain industrial processes. Air pollution is most marked in urban areas. *See also* photochemical smog.

atmospheric pressure Downward force exerted by the weight of the overlying atmosphere, expressed per unit area in a given horizontal cross-section. Pressure varies throughout the atmosphere, owing to the distribution of mass; there are small diurnal variations of partly tidal and partly thermal origin, as well as bigger changes associated with the passage of depressions and anticyclones. Atmospheric pressure is measured in millibars (mb), 1 mb being equal to 100 pascals (Pa). Measurements are usually made with a mercury barometer. The overall global average pressure at sea level is 1013.25 mb, but as air is readily compressible, pressure decreases exponentially with altitude.

atmospheric structure The broadly horizontal layering of the atmosphere, the layers being distinguished by differences in the rate of change of temperature with height, which either favour or discourage the development of vertical exchanges (convection). From the surface of the Earth upwards the layers are: the troposphere, in which convection is often prominent, especially over warm regions, extending to the tropopause at a somewhat variable height, generally about 11 km over middle and higher latitudes and 17 km near the equator; the stratosphere, in which there is much less vertical motion, and which extends to about 50 km at the stratopause; the mesosphere, in which there is once again more convection, extending to a height of about 80 km at the mesopause; and the thermosphere, extending to the effective limit of the atmosphere, at about 200 km. *See also* mesosphere; stratosphere; thermosphere; and troposphere.

atmospheric 'window' The range of wavelengths (about 8.5-11 μm) at which radiation is only slightly absorbed by water vapour. Terrestrial radiation within this range may escape into space unless it is absorbed by cloud. *See also* greenhouse effect; and terrestrial radiation.

atoll Ring-shaped organic reef that encloses or almost encloses a lagoon, and which is surrounded by the open sea. The reef may be built of coral and/or calcareous algae. An atoll is built on an

existing structure such as an extinct, submerged volcano. *See* reef.

ATP *See* adenosine triphosphate.

Atrax robustus *See* funnel-web spiders.

Atrichornis clamosus (noisy scrub-bird) *See* Atrichornithidae.

Atrichornithidae (scrub-birds; order Passeriformes) Family of small, brown birds, with short, round wings, and long, graduated tails. They have powerful voices, especially *Atrichornis clamosus* (noisy scrub-bird). They are insectivorous, strongly territorial, and are found only in the dense undergrowth of two isolated areas of coastal Australia. There is one genus, containing two species.

Atrichum undulatum *See* Catherine's moss.

Atriplex (family Chenopodiaceae, tribe Cyclobeae) Genus of herbs and small shrubs which are generally halophytic. The stems are often striated with red or white, and the plant is often mealy. The leaves are alternate, toothed or lobed, linear or triangular, and without stipules. The flowers are inconspicuous, unisexual, and held in small cymes. The perianth of the male flower is composed of 2–5 segments, usually green in colour, and there is a similar number of stamens. The female flower is without any perianth, but is enclosed by two persistent bracteoles, which can be entire or lobed. The superior ovary is composed of three fused carpels, and a single locule with one ovule. The fruit is an achene. There are about 100 species, found throughout the world, often as components of open communities or grassland, on soils rich in organic salts, e.g. in coastal areas.

atrium 1 In Urochordata and Cephalochordata, a chamber surrounding the pharyngeal region which receives water from the pharyngeal clefts and opens to the exterior through an atriospore. 2 *See* auricle.

atropine Substance that, by competing with acetylcholine for post-synaptic membrane receptor sites, inhibits the passage of nerve impulses across a synapse.

Atterberg limits Series of thresholds, first studied by Atterberg, which are observed when the water content of a soil is steadily changed. The 'contraction limit' occurs when sufficient water is added to a dry soil for contraction cracks to close. The addition of further water leads to plastic deformation at the 'plastic limit'. The 'liquid limit' occurs when just enough water is then added for the soil to behave like a liquid. Knowledge of these limits is important for understanding and predicting hillslope failure.

Attila (attilas; family Tyrannidae) Genus of birds, most of which are rufous with coloured rumps. They have straight, hook-tipped bills. They inhabit forest areas, and feed on insects near the ground or at tree-top height. There are six species, found in S. America. Formerly they were placed in the Cotingidae.

Attini (order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Myrmicinae) Tribe of fungus-feeding ants in which foliage cut by foraging workers provides a substrate for the growth of a fungus, localized in fungus gardens within the soil nest. Fungal gongylidia (hyphae with swollen tips) are harvested by workers and fed to larvae. Each mature colony of *Atta sexdens* may have three million workers, produced by a single queen whose life-span may be eight years or more. There are 200 species, restricted to the New World, where most occur in the neotropics.

Atypidae (purse-web spiders; order Araneae, suborder Mygalomorphae) Family of spiders, all less than 3 cm long, which have three tarsal claws and six spinnerets. The species are robust, with massive chelicerae, and two pairs of book lungs. New World species construct open silk tubes on the sides of trees; European species construct the tubes on the ground. In all cases, prey walking over the tube is impaled on the fangs and dragged through the purse web. The three species of *Atypus* are the only Mygalomorphae found in N. Europe. *Atypus* is also found in the eastern USA, Burma, Java, and Japan. The few species in this family may live for up to nine years.

Atypus affinis (purse-web spider; suborder Mygalomorphae, family Atypidae) Species of purse-web spider which has a brown or greenish-brown, glossy carapace, and a dark reddish-brown abdomen that is marked with small grey spots. Females can attain lengths of 15 mm, and males 9 mm. Tube webs are usually made under cover of low vegetation in sandy or chalky soil. The species has been recorded throughout the UK, but is local in northern areas.

aubemouth *See* Aulorhynchidae.

Auchenipteridae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater catfish, distinguished by having a scaleless body, a zigzag lateral line along the body, a tiny adipose fin, and pairs of barbels around the mouth. There are about 25 species, found in tropical S. America.

Auckland Island merganser (*Mergus australis*) *See Mergus*.

Aucoumea (family Burseraceae) Genus of one species, the big West African rainforest timber tree gaboon (*A. klaineana*), which also produces resin.

Aucuba (family Cornaceae) Genus of dioecious, evergreen shrubs in which the leaves are opposite, and the fruit is a berry. *A. japonica* tolerates shade and is commonly planted. There are three or four species, occurring in temperate E. Asia.

auditory meatus Canal leading from the external ear to the tympanic membrane.

aufwuchs *See* periphyton.

auger Tool used primarily for soil sampling, but also for sampling peats and other unconsolidated sediments. The simplest and most universal form has a screw head to bore the soil or sediment. Alternative auger heads are available for more specialized needs. Standard augers sample to one metre depth, but extension rods can be attached enabling sampling at deeper levels.

auks 1 *See* Alcidae; and Charadriiformes. 2 (little auk, *Alle alle*) *See Alle*. 3 *See Fratercula*.

aulacogen Large linear trough bounded by high-angle fault planes; a rift structure that may begin as a graben. Examples can be identified as far back as the Early Proterozoic, and occur on all continental land masses. It is a failed arm of a triple junction.

aulodont Applied to echinoids with a lantern characterized by teeth which are longitudinally grooved and broadly U-shaped in cross-section.

Aulopodidae (class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine, warm- to temperate-water fish. All species possess a rather large head, big jaws, a high dorsal fin, and a slender body. *Aulopus purpurissatus* (Sergeant Baker) is well known in Australia. It is a beautifully coloured species of up to 50 cm body length. There are about eight species.

Aulorhynchidae (aubemouth; class Osteichthyes, subclass Actinopterygii, order Gasterosteiformes) Family of marine coastal fish with a very elongate body, and tube-like snout. The first dorsal fin consists of about 25 short, isolated spines. They occur in the N. Pacific.

Aulostomidae (flutemouth, trumpetfish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Family of marine tropical fish characterized by a very elongate body, a long compressed snout, a series of isolated dorsal spines, and a rounded tail-fin. Found mainly in reefs or inshore rocky areas, they can be encountered swimming in an almost vertical position, hidden by seagrass leaves or coral branches. There are about four species.

aureole The luminous white or bluish disc, surrounded by a brown ring, sometimes observed directly surrounding the Sun or Moon. The term is also used to describe the bright area with no definite boundary commonly seen surrounding the sun in a clear sky. *See also* corona.

auricle 1 (atrium) Chamber of a heart into which blood flows from veins and from which blood flows to a ventricle. 2 External ear. 3 Appendage, which may resemble the ear of an animal, occurring at the base of the leaf blade of a plant. 4 Internal projection from one of the ambulacral plates around the peristome of echinoids which serves for the attachment of muscles supporting the lantern.

Auricularia (order Auriculariales) Genus of fungi in which the fruit bodies are gelatinous but firm, and may be cup-shaped, ear-shaped, discoid, etc. The hymenium is borne on one side of the fruit body. *A. auricula* (also known as *Hirneola auricula-judae*) is the 'jew's ear' fungus which is a common parasite on elder (*Sambucus*) and other trees. *A. mesenterica* has a resupinate fruit body with a velvety surface and a jutting, shelf-like upper margin. It is common throughout the year on hardwood stumps and logs. There are 10 species.

auricularia larva In Asteroidea and Holothuroidea, a larval form in which a ciliated band outlines the body.

Auriculariales (subclass Phragmobasidiomycetidae) Order of fungi in which the basidium is divided by transverse septa. Fruit bodies are typically gelatinous or waxy. They are saprotrophic, or parasitic on plants. There is one family, with many genera.

Auriscalpiaceae (order Aphyllophorales) Family of fungi in which the hymenium is borne on tooth-like spines, or on gills. The family contains genera formerly included in the Hydnaceae.

aurora Illumination of the sky, sometimes in brilliant colours, as a result of high-speed solar particles entering the ionosphere (at a height of 100–130 km) and releasing electrons from air molecules by excitation. The re-establishment of molecules leads to the emission of light, especially red- and green-coloured light, e.g. in arcs or bands over large areas. The effect is called 'aurora borealis' or 'northern lights' in the northern hemisphere and 'aurora australis' or 'southern lights' in the southern hemisphere. Such atmospheric disturbances occur in relation to disturbances on the Sun in the course of the sunspot cycle.

Australasian rain forest *See* African rain forest.

Australia cedar *See Toona*.

Australian bluebell *See Wahlenbergia*.

Australian bower plant *See Pandorea*.

Australian chats *See* Ephthianuridae.

Australian faunal region Region distinguished by a unique marsupial fauna, including herbivores, carnivores, and insectivores. These evolved in isolation from the placental mammals which now dominate the other continental faunas. In addition to marsupials there are also very primitive mammals (monotremes), the spiny ant-eater and the platypus; and small rodents which are relatively recent (probably Miocene) immigrants.

Australian grayling (*Prototroctes maraena*) *See* Aplochitonidae.

Australian laurel *See Pittosporum*.

Australian lungfish *See* Ceratodidae.

Australian magpie (*Gymnorhina tibiren*) *See Gymnorhina*.

Australian rosewood *See Heterodendrum*.

Australian salmon (*Arripis trutta*) *See* Arripidae.

Australian sassafras (*Doryphora sassafras*) *See Doryphora*.

Australian tree-creepers *See* Climacteridae.

Australian turpentine *See Syncarpia*.

Australian wrens *See* Maluridae.

australopithecines Literally 'southern ape men', these early protohominids of the Pliocene and early Pleistocene (living 3–1.5 million years ago) are known only from Africa. Though placed formerly in a genus, *Australopithecus*, the 'robust australopithecines' are often referred nowadays to a genus *Paranthropus*, while the 'gracile australopithecines' are called *Homo africanus*.

austral region *See* circum-austral distribution.

Austrilina (family Urticaceae) Genus of annual and perennial herbs which are often creeping. The leaves are alternate or opposite, with petioles and small stipules. The unisexual flowers are held in axillary clusters. They are small and green. The male flowers are single, or in groups of up to five on a common stalk. The perianth is two-lobed and there is a single stamen. The female flowers are usually solitary or in a small cluster with a tubular, slightly toothed perianth, which persists until fruiting, along with the stigma. There are about five species, found in Australia, New Zealand, and S. Africa.

autapomorph Apomorph character state that is unique to a particular species or lineage in the group under consideration.

autecology Ecology of individual organisms and populations, including physiological ecology, animal behaviour, and population dynamics. Usually only one or two species are studied. *Compare* synecology; *see also* population ecology.

authigenic Applied to mineral particles formed at or close to the surface, or to soils containing such particles.

autochthonous Indigenous, applied for example to organisms in a particular habitat. In geology, the term refers to a geological material, e.g. dripstone, that was formed in its present position. No significant transport has been involved. *Compare* allochthonous.

autoecious (monoxenous) Applied to a parasitic organism that can complete its life cycle in a single host species.

autogamy Process of self-fertilization found in some protozoa, e.g. *Paramecium*, and in some diatoms: the nucleus of an individual divides into two parts which then reunite, resulting in homozygosis (the production of identical alleles at any gene locus on homologous chromosomes).

autogenic Applied to a successional change due to modification of the environment by vegetation, e.g. by producing humus or providing shade. *Compare* allogenic; *see also* succession.

autograft *See* allograft; and graft.

autogrooming Grooming of an animal by itself. *Compare* allogrooming.

autoimmunity Immune reaction in an organism in which the same individual acts as the source of both antigens and antibodies. While it may arise as a result of a pathological and therefore undesirable condition, it is also an integral part of the mechanism in the body for eliminating unwanted cells, e.g. old erythrocytes.

autolysis Destruction of a cell or some of its components through the action of its own hydrolytic enzymes. It is a process that is particularly marked in organisms undergoing metamorphosis.

automatic weather station Meteorological station that records measurements of atmospheric pressure, temperature, humidity, or wind, and details of weather conditions, and transmits them automatically to a central base.

automimicry Presence of a polymorphism for palatability to predators. In the unpalatable monarch butterfly, for example, it arises from the particular toxic food plants which are chosen by the ovipositing female. After hatching from the egg the larvae feed on the plant, taking in substances that are toxic to birds but not to the insects themselves. This renders them unpalatable to predators. The situation is used to advantage by palatable members of the species, which mimic the coloration of the unpalatable ones and so obtain protection. The polymorphism is frequency-dependent, and the unpalatable insects must be more abundant—and hence more frequently encountered by the bird predators—than the palatable insects.

autonomic Applied to behavioural responses (e.g. pallor and sweating in humans in response to fear) produced by the autonomic nervous system. Certain ritualized forms of behaviour used in communication may have originated as autonomic behaviour.

autophagic vacuole Membrane-bound vacuole, derived from within the cell, containing material to be digested. *See also* lysosome.

autopolyploid Polyploid organism that originates by the multiplication of a single genome (set of chromosomes) such that all the chromosomes come from sets within one single species.

autosome Any chromosome in the cell nucleus other than a sex chromosome.

autotetraploid Autopolyploid with four similar genomes. They occur either naturally by the spontaneous accidental doubling of a $2n$ genome to $4n$, or artificially, through the use of colchicine. They are present in many commercially important crop plants because, as with other polyploids, they tend to be associated with increased size of the plant (through increased cell size, fruit size, stomata size, etc.).

autotheca One of the three types of graptolite thecae, possibly containing the female zooid. *Compare* bitheca; and stolotheca.

autotomy *See* lizards.

autotroph Organism that uses carbon dioxide as its main or sole source of carbon. *Compare* heterotroph.

autoxidation *See* antioxidant.

autumnal In the autumn (fall). The term is used with reference to the six-part division of the year used by ecologists, especially in relation to studies of terrestrial and freshwater communities. *Compare* aestival; hibernal; prevernal; serotinal; and vernal.

autunite Secondary mineral, specific gravity 3.1, hardness 2.5, and with the chemical composition $Ca(UO_2)(PO_4)_2.10–12H_2O$. It occurs with torbernite in the oxidized zone of mineral veins. It is distinguished by its yellow-green colour, and its crystal form. The colour is usually bright lemon-yellow to greenish-yellow, and the mineral has a

yellow streak, and a vitreous lustre. It crystallizes in the tetragonal system. The crystals are tabular and square in shape; and form foliated, scaly masses.

auxin Hormone which promotes longitudinal growth in the cells of higher plants. Typically, low concentrations of auxin promote growth whereas high concentrations inhibit it. Auxins are produced at the growing points of stems and roots, and promote growth by increasing the rate of cell elongation rather than that of cell division. They are involved in the curvature of parts of the plant towards light (phototropism) or gravity (geotropism), and the initiation of cambium activity in association with cytokinins; and they may control fruit growth or leaf fall, and inhibition of lateral-bud development in favour of apical buds. A natural example of an auxin is indole-3-acetic acid (IAA), which has been isolated from fungi and bacteria, and from the endosperm of corn, as well as from urine and saliva in humans. Auxins have also been synthesized, and are widely used to regulate growth in a variety of plants of agricultural and horticultural importance. Some of these may have differential effects on different plants. For example 2,4-dichlorophenoxyacetic acid (2,4-D) is toxic to dicotyledons but not to monocotyledons, and is used to control weeds in cereal crops and lawns.

auxotroph Organism (usually a bacterium) that, as a result of a mutation, has lost the ability to synthesize a particular substance essential for its growth, e.g. an amino acid or a sugar. The organism must be able to obtain this component from its environment if it is to survive and grow. *Compare* prototroph.

available nutrients Any elements or compounds in the soil solution that can be absorbed readily into plant roots, and that function as nutrients to growing plants. The available amount is usually much less than the total amount of that plant nutrient in the soil.

available relief The part of a landscape that is higher than the floors of the main valleys. It is therefore available for destruction by the agents of erosion, controlled by the local base level. It is measured by the vertical distance between hilltops and valley floors.

available water In soil, the water that can be absorbed readily by plant roots. It is usually taken to be water held in the soil under a pressure of 0.3 to about 15 bars.

avalanche *See* mass-wasting.

avalanche wind A 'blast' of often very destructive air ahead of a descending avalanche.

Avena fatua (wild oats) *See* herbicide.

Averrhoa (family Oxalidaceae) Genus of two species of small trees widely cultivated throughout the tropics for their edible, fleshy, many-seeded fruits. *A. bilimbi* (bilimbing) has acid fruits like small cucumbers, *A. carambola* (carambola) has elongate 5-angled fleshy berries, sweet or acid, and is also used for cleaning brassware.

Aves (birds; subphylum Vertebrata, superclass Gnathostomata) Class comprising all the birds. *Archaeopteryx* is the oldest fossil bird known, dating from the Upper Jurassic. It had many primitive features that point clearly to an archosaurian reptile ancestry. With the exception of *Hesperornis*, a toothed diving bird, little is known of Cretaceous birds. The major phase of avian evolution may be consigned confidently to the Tertiary, when many of the modern orders appeared.

avian tubercle bacillus (*Mycobacterium avium*) *See Mycobacterium*.

Avicennia (family Verbenaceae or Avicenniaceae) Genus of small trees with greyish, opposite leaves. The flowers are small and regular, the calyx and corolla imbricate, the ovary superior. The fruit is a roundish, bivalved capsule with one seed. There are 15 species, occurring on tropical coasts, mainly in mangrove forests at their ecological and geographical limits.

avicularium In some polymorphic colonial Bryozoa, a zooid shaped like the head of a bird.

avirulent Not virulent.

avocado pear (*Persea americana*) *See Persea*.

avoidance Behaviour that tends to protect an animal by reducing its exposure to hazard. Avoidance behaviour may be learned (e.g. when an animal does not enter an area in which a predator has been encountered, or when it does not eat an item that previously made it ill), or innate (e.g. when the young of some bird species utter distress calls and seek to hide when they see the shadow of a hawk-like object, although they have no experience of predatory birds).

avulsion Lateral displacement of a stream from its main channel into a new course along the outer edge of its floodplain. Normally it is a result of the instability caused by channel aggradation. The avulsion of a stream into an adjacent valley may explain some cases of apparent river capture.

awn In grasses, the continuation of the central nerves of the lemmas or glumes, which often form a projecting point from the spikelet.

axenic Of a culture of an organism: consisting of one type of organism only, i.e. free from any contaminating organisms.

axial plane The plane that bisects the angle between the two limbs of a fold. *See* fold.

axil In a plant, the upper angle where a small stem joins a larger one, or where a leaf stalk joins the stem.

axile *See* placentation.

axillary Borne in an axil. For example, an axillary bud lies between the twig and a subtending leaf.

Axinellida (class Demospongiae, subclass Tetractinellida) Order of sponges which possess large amounts of organic fibres which envelop the spicules. An axial skeleton normally occurs. All species are oviparous.

axis vertebra The second vertebra of the neck.

axolotl (*Ambystoma mexicanum*) *See* Ambystomatidae.

axon Single, long, straight, relatively unbranched process arising from the cell body of a neuron, which may or may not be myelinated. It is responsible for conducting the nerve impulse away from the cell body.

axoneme The '9 + 2' formation of microtubules that forms the principal structural feature of cilia and flagella.

axoplasm The cytoplasm of an axon.

axopodium Type of pseudopodium which is slender, and which possesses a central filament or core. Axopodia extend radially from the cell bodies of sarcodine protozoa.

aye-aye (*Daubentonia madagascariensis*) *See* Daubentoniidae.

Aysheaia pedunculata Described by Walcott, this species is one of a few referred to the arthropod order Protoonychophora. It possessed an elongate, worm-like body with a terminal mouth and frontal pupillae. The body was segmented and bore 10–43 pairs of walking legs. Although marine, *Aysheaia* is considered a likely ancestor for the extant onychophorans that exist in humid tropical forests.

Aythya (pochards; family Anatidae) Genus of diving ducks with the feet set well back, and a lobed hind toe. Most inhabit fresh water, but some feed in sea water. Most are omnivorous. They nest on the ground. There are 12 species, found mainly in the northern hemisphere where they are migratory, but also in Australasia and Madagascar.

ayu *See* Plecoglossidae.

Azadirachta (family Meliaceae) Genus of big trees which yield valuable timber. The fruit is a capsule, with a few large seeds which have fleshy jackets. There are two species, occurring in Indo-Malaysian rain forests.

Azollaceae Specialized family of free-floating, aquatic ferns of uncertain affinities. The branched stems bear roots, and two-lobed, overlapping leaves. Sori bear either microsporangia or megasporangia. The megasporangia are each provided with floats; microspores are numerous and grouped together into 'massulae' which bear barbed hairs (glochidia) that hook on to the megaspores. There is one genus, *Azolla*, with six species, of tropical and warm-temperate distribution in America and Asia. They are not native in Europe, but are naturalized there.

Azores high Semi-permanent anticyclonic region with subsiding air over the Atlantic Ocean at around 30° N latitude. Movement of the system poleward in summer has a major impact upon the climate of Europe. The aridity of the Sahara Desert and the adjacent Mediterranean region is due to the subsidence of air in this high-pressure system. *See* air mass.

Azotobacter (family Azotobacteraceae) Genus of bacteria characterized by the production of differentiated resting cells called 'cysts'. Vegetative cells are ovoid in shape and can carry out nitrogen fixation. There are several species, found in soil and water.

Azotobacteraceae Family of bacteria in which the cells are typically Gram-negative, and rod-shaped or variable in shape. They are chemo-organotrophic, and can grow only in the presence of air. Species are capable of converting atmospheric nitrogen into an organic form that can be incorporated into the cells (a process called nitrogen fixation). They are saprotrophic, and are found in soil, water, plant material, etc. There are several genera.

azurite Secondary mineral, specific gravity 3.9, hardness 3.5–4.0, and with the chemical composition $Cu_3(CO_3)_2(OH)_2$. It occurs in the oxidized zone of copper deposits and is associated with malachite, but is less widespread. It is distinguished by its colour and by its solubility in nitric or hydrochloric acid, with effervescence. Its colour is various shades of deep azure blue, with a light-blue streak, and it has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are often tabular or short prisms, and radiating aggregates. It is an ore for copper.

azygospore Fungal spore which resembles a zygospore but which develops parthenogenetically.

B

babaçu palms (*Orbignya speciosa*) *See Orbignya*.

babblers 1 *See* Timaliidae; and *Turdoides*. 2 (jungle babblers) *See Trichastoma*.

Babesia (class Piroplasmea) Genus of protozoa comprising organisms which are parasitic in the red blood cells of animals and can cause disease. *See also* red-water fever.

baboon (*Papio*) *See* Cercopithecidae.

Baccaurea (family Euphorbiaceae) Genus of small, dioecious trees in which the flowers are borne in clustered spikes or racemes, some cauliflorous. The fruit has a firm, fleshy pericarp which sometimes splits, and 1–6 large seeds, each with a juicy, sour jacket. Several species are edible, and some are cultivated. There are 80 species, occurring in lowland rain forest from Malesia to the Pacific islands.

Bacillaceae Family of bacteria in which the cells are mostly rod-shaped. Members are characterized by the formation of a type of differentiated resting cell, an endospore, which is highly resistant to adverse environmental conditions, e.g. desiccation, or high temperatures. There are several genera, found in a wide range of habitats. Some can cause disease.

Bacillariophyceae (diatoms) Class of algae which are mostly unicellular, but which may be colonial or filamentous. The cell wall (frustule) is composed of silica and consists of two halves, one of which overlaps the other like the lid on a box. The frustule is commonly delicately ornamented. Most diatoms are photosynthetic, but there are also species which lack chlorophyll and live heterotrophically among decaying marine algae. Some species are capable of a gliding motility when in contact with a surface. Cells with bilateral symmetry are said to be pennate, while those with radial symmetry are called centric. Pennate diatoms are found in both freshwater and marine habitats, either as plankton or attached to rocks, etc.; centric diatoms are predominantly marine.

Bacillus (family Bacillaceae) Genus of bacteria in which the cells are rod-shaped, often motile, and typically Gram-positive. Endospores can be formed in the presence of air. *Bacillus* species are chemo-organotrophic. Some can grow only in the presence of air; others can grow in either the presence or absence of air. There are many species, found in a wide range of habitats. Some species can cause disease in vertebrate animals (e.g. anthrax), or in insects.

bacillus Bacterial cell that is rod-shaped, i.e. longer than it is wide.

back-calculation Method used by fishery biologists to determine past body lengths of fish: it uses certain formulae expressing growth relationships between scale and body length.

backcross Cross of an F_1 hybrid or heterozygote with an individual of genotype identical to that of one or other of the two parental individuals. Matings involving a hybrid genotype and a recessive parental genotype are used in genetic analyses to determine linkage and cross-over values.

backing Anticlockwise shift of the direction of the wind. The reverse change is called veering.

back mutation Reverse mutation (i.e. reversion) in which a mutant gene (called the non-wild-type form) reverts to the original standard form (the wild-type form).

backreef Area behind, or to the landward of, a reef. This zone usually includes a lagoon between the reef and the land.

backshore The part of a beach that is above the level of normal high spring tides. This zone is usually dry; only when exceptionally high tides or storms occur does wave action influence this part of a beach.

backswamp Area of low, ill-drained ground on a floodplain away from the main channel. It stands slightly lower than adjacent alluvial fans extending from the valley sides, and is below natural levées that rise towards the main channel. It is a site of slow accumulation of silts and clays.

backswimmer *See* Notonectidae.

backwash Seaward return of water down a beach. The process is affected by wave height and frequency, and by beach properties such as gradient and permeability. The general effect is to steepen the beach profile.

bacon beetle (larder beetle, *Dermestes lardarius*) *See* Dermestidae.

bacteraemia Condition in which bacteria are present in the blood.

Bacteria (kingdom Prokaryotae) A division of microscopic, prokaryotic organisms which show a vast range of forms and types. There is no single feature that is common to all bacteria apart from their prokaryotic cellular organization, a feature that they share with the cyanobacteria (blue-green algae). The majority of bacteria are single-celled, and most have a rigid cell wall. Cell division usually occurs by binary fission; mitosis never occurs. Bacteria are almost universal in distribution and may live as saprotrophs, parasites, symbionts, pathogens, etc. They have many important roles in nature, e.g. as agents of decay and mineralization, and in the recycling of elements (such as nitrogen) in the biosphere. Bacteria are also important to

humans, e.g. as causal agents of certain diseases, as agents of spoilage of food and other commodities, and as useful agents in the industrial production of commodities such as vinegar, antibiotics, and many types of dairy products. The oldest fossils known are of bacteria, from rocks in S. Africa that are apparently 3200 million years old. These must have been heterotrophic bacteria, feeding off organic molecules dissolved in the oceans of that time. The first photosynthetic bacteria, of anaerobic type, appeared a little later, about 3000 million years ago.

bactericidal Applied to any agent that kills bacteria.

bacteriochlorophyll Chlorophyll occurring in small vesicular bodies attached to the cell membrane in photosynthetic bacteria. It differs from the chlorophyll found in higher plants in that the double bond between C_3 and C_4 is replaced by a single bond and the vinyl group at C_2 is replaced by an acetyl group. As a result of this some of the major absorption bands of bacteriochlorophyll are displaced to the far-red at 800–850 nm.

bacteriocin Substance, produced by a particular strain of bacteria, that is lethal to other, often related, strains of bacteria.

bacteriophage (phage) Type of virus which infects bacteria. Infection with a bacteriophage may or may not lead to the death of the bacterium, depending on the phage and sometimes on conditions. A given bacteriophage usually infects only a single species or strain of bacterium. Phages can be found in most natural environments in which bacteria occur.

bacterio-rhodopsin Pigment-containing protein found in certain species of bacteria of the genus *Halobacterium*. Bacterio-rhodopsin is responsible for a unique method of harnessing the energy of sunlight for use by the bacteria.

bacteriostatic Applied to an agent that prevents the growth of bacteria without actually killing them.

bacterium 1 A single bacterial cell. 2 A particular species of organism of the division Bacteria.

bacteroid Modified bacterial cell, particularly of the type formed by species of *Rhizobium* within the root nodules of leguminous plants.

Bacteroidaceae Family of Gram-negative bacteria in which the cells are rod-shaped, and motile (with many flagella) or non-motile. They are chemo-organotrophic, and can grow only in the absence of air. They are parasitic in humans, other vertebrate animals, and insects; some can cause disease. There are three genera.

Bacteroides (family Bacteroidaceae) Genus of Gram-negative bacteria which can grow only in the absence of air. They are found in the lower intestine of humans and other animals, in the rumen, and in sewage. Some species can act as 'opportunist' pathogens and have been isolated from various soft-tissue infections. There are many species.

Bactrian camel (*Camelus bactrianus*) *See* Camelidae.

baculoviruses Group of DNA-containing viruses which infect insects, causing diseases known as granuloses and polyhedroses.

baculum Name sometimes given to the penis bone of some mammals.

badger (*Meles*, *Taxidea*) *See* Mustelidae.

badlands Term originally applied to the intricately eroded plateau country of S. Dakota, Nebraska, and N. Dakota, USA, but now widened to refer to any barren terrain that has been similarly dissected. It is most common in areas of infrequent but intense rainfall and little vegetation cover.

bael fruit (*Aegle marmelos*) *See Aegle*.

baeocyte Type of reproductive cell (previously called an endospore), many of which are formed within a cell in cyanobacteria of the order Pleurocapsales.

Baeomycetaceae (order Lecanorales) Family of lichens in which solitary apothecia are borne on short, unbranched stalks. Spores are multicellular. They are found mainly on acidic substrates, e.g. acid rocks, or peaty soil.

bagassosis Disease of the lung occurring in workers exposed to dust from sugar-cane waste. The causal agent may be an actinomycete.

Bagre marinus (gaff-topsail catfish) *See* Ariidae.

Bagridae (bagrid catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of freshwater catfish which are recognizable by a large, adipose dorsal fin, small eyes, and four pairs of barbels around the mouth. Many of the smaller species are of interest to aquarium hobbyists. Some (e.g. *Bagrus docmac* from Africa) may reach a length of up to 1 m. The family is distributed widely in tropical Africa and Asia.

baguio Regional term for tropical storms (cyclones or typhoons) in the Philippine Islands. Also used specifically for a type of cyclone in these islands that occurs between July and November.

bagworms *See* Psychidae.

bahada *See* bajada.

Baikal oilfish *See* Comephoridae.

Baikal sculpins *See* Cottocomephoridae.

Bai-u season The principal rainy season of the SE monsoon in southern and central Japan.

bajada (bahada) Extensive, gently sloping plain of unconsolidated rock debris resting against the foot of a mountain front in a semi-arid environment. Typically it is made of a number of coalescing alluvial fans laid down by ephemeral streams as their gradients lessen on leaving the mountain zone. Material is also supplied by the weathering of the mountain front. Alternatively, it may comprise the alluvial accumulation on the lower part of a pediment.

bakanae disease (foolish seedling disease) Important disease of rice in which early symptoms include excessive growth of the stem. The disease is caused by the fungus *Gibberella fujikuroi*.

bakers' yeast Strains of *Saccharomyces cerevisiae* used in bread-making. *Compare* brewers' yeast.

Balaena glacialis (right whale) *See* Balaenidae.

Balaena mysticetus (bowhead whale) *See* Balaenidae.

Balaeniceps rex (shoe-bill) *See* Balaenicipitidae.

Balaenicipitidae (shoe-bill; order Ciconiiformes) Monotypic genus, comprising *Balaeniceps rex*, a grey, stork-like bird with a huge, broad, flattened bill. It is found in swamps feeding on fish, and it nests on the ground. It occurs in tropical E. Africa.

Balaenidae (order Cetacea, suborder Mysticeti) Family comprising the right and bowhead whales. The body is robust, the snout blunt, the throat ungrooved. A dorsal fin is present in some species. The flippers are broad and short. The posterior margin of the tail is notched at the midline. The cervical vertebrae are fused. The baleen plates are long and narrow, and left and right rows are separated anteriorly. The animals are dark grey or black and feed on plankton. *Balaena mysticetus* (bowhead whale) is confined to northern waters, *Caperea* (pygmy right whale) to the southern hemisphere, and *B. glacialis* (right whale) occurs in both hemispheres. They grow to about 6 m (*Caperea*) or 20 m (*Balaena*). There are two genera, and three species.

Balaenoptera acutorostrata (minke, lesser rorqual) *See* Balaenopteridae.

Balaenoptera borealis (sei whale) *See* Balaenopteridae.

Balaenopteridae (Order Cetacea, suborder Mysticeti) Family that includes the fin, humpback, and blue whales. The body is streamlined, the snout pointed, the throat and chest grooved. The dorsal fin is hooked and set far back on the body. The tail is slightly notched at the midline, and scalloped along the posterior edge. The cervical vertebrae are not fused. The baleen plates are broad and short, the left and right rows being joined anteriorly. The animals are typically grey on the dorsal surface, with some white on the ventral surface; but *Megaptera* (e.g. *M. novaengliae*, humpback) may be black above and below, with white flippers. They feed on krill and small fish, and occur in both hemispheres. They grow to 7–30 m depending on species. There are six species, in two genera: *Balaenoptera* (e.g. *B. acutorostrata*, minke or lesser rorqual; *B. borealis*, sei; *B. physalus*, fin; *B. musculus*, blue; *B. edeni*, Bryde's) and *Megaptera*.

balanced polymorphism Genetic polymorphism that is stable, and is maintained in a population by natural selection, because the heterozygotes for particular alleles have a higher adaptive value (fitness) than either homozygote. This condition is also referred to as overdominance, as opposed to underdominance where the homozygote has a lower fitness, giving rise to unstable equilibrium.

Balanidae (acorn barnacles; order Thoracica, suborder Balanomorpha) Family of radially symmetrical, balanomorph barnacles in which the third pair of cerci resemble the second rather than the fourth, and in which there are no caudal appendages. The family includes the familiar barnacles exposed at low tide, of the genus *Balanus*, which has been divided into 10 subgenera.

Balanopaceae *See* Balanopsidaceae.

Balanophoraceae Family of plants which are obligate parasites attached to roots. A tuberous, subterranean, knobbly rhizome with no chlorophyll bears stout aerial spikes on which are borne minute male and female flowers and then tiny nuts, or drupes. There are 18 genera, and 120 species, occurring in rain forests throughout the tropics.

Balanopsidaceae (Balanopaceae; order Fagales) Small family of dicotyledonous trees and shrubs. The leaves are alternate or whorled. The flowers are simple; male flowers are borne in catkins on separate trees from the female flowers, which are solitary with scale-like perianths. The fruit is an acorn-like drupe. The family comprises one genus, with 12 species, native to Queensland and the SW Pacific.

Balanus (acorn barnacle) *See* Balanidae.

balata The latex of *Manilkara bidentata* (family Sapotaceae), obtained from incising the trunk, formerly of considerable commercial importance.

balau Malay name for trees of the genus *Shorea*, (subfamily Diptesocarpoideae) valuable for their timber.

Balbiani ring *See* chromosomal puff.

bald crows *See* Picathartidae.

baleen In Mysticeti, sheets of keratin which hang transversely from the roof of the mouth, their lower edges fringed with hairs which form a comb-like structure used to filter plankton.

baleen whales *See* Mysticeti.

Balistidae (triggerfish, filefish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Large family of marine fish, all of which have rather compressed, deep bodies with a large, stout, first dorsal spine that can be locked into a vertical position when erected. While some filefish show cryptic coloration, others, e.g. *Balistoides conspicillum* (clown triggerfish), have brilliant colour patterns. There are at least 120 species, many of which are sometimes considered to belong to an alternative family (Aluteridae or Monacanthidae). They occur in tropical and subtropical waters.

Balistoides conspicillum (clown triggerfish) *See* Balistidae.

balk (bauk, baulk) Roughly squared, large piece of timber used for beams, etc.

ballistospore Type of fungal spore which is projected violently from its sporophore at maturity.

ballooning *See* Araneae; and Linyphiidae.

balloon sounding Use of lighter-than-air balloons to establish wind conditions in the upper air. Usually the balloons are tracked by radar, and instruments attached to the balloons may record temperature and humidity at given pressure levels. *See also* radiosonde; and rawinsonde.

Balsaminaceae Family of herbs with brittle, translucent stems, and simple leaves. The flowers have 3–5 sepals and five petals, usually all coloured and strongly zygomorphic, the lowest sepal being large, spurred, and petal-like. The fruits are capsules, exploding if touched when ripe. Several are cultivated for their showy flowers. There are two genera, one (*Hydrocera*) monotypic, occurring only in SE Asia, the other (*Impatiens*) (balsams, or touch-me-nots) of more than 200 species, mostly of tropical Asia and Africa, but with a few in northern temperate America and Eurasia, and in S. Africa.

balsams (*Impatiens*) *See* Balsaminaceae.

Baluchitherium *See* Rhinocerotidae.

bamboo *See* Bambusaceae.

bamboo borer (*Dinoderus minutus*) *See* Bostrichidae.

bamboo rats *See* Rhizomyidae.

bamboo worms *See* Sedentaria.

Bambusaceae (bamboos) Family closely related to the grasses (Gramineae) and sometimes considered to be a subfamily (Bambusoideae) of them. Nearly all have woody stems, a few are herbs. The tallest grow to 40 m, the stoutest to 90 cm girth. Usually they are clump-forming, with a big underground rhizome. They fruit annually, or at long intervals, and then die. The fruit is dry, or occasionally fleshy. Many are of major economic importance for building, scaffolding, or paper making, or for the edible young shoot tip. Some whole cultures in Asia are based on bamboos. There are about 45 genera, mainly tropical and subtropical, and most diverse in S. America.

Bambusoideae *See* Bambusaceae.

banak *See Virola*.

banana *See Musa*.

band Vertical stripe on a polytene chromosome resulting from the specific association of a large number of chromomeres (small band-like structures visible on a chromosome during prophase of meiosis and mitosis). The most commonly examined polytene chromosomes are in the salivary-gland nuclei of insects, and recent studies of *Drosophila* suggest that each band contains the genetic material of a single gene. However, the significance of the bands in human and other chromosomes is not known.

banded ant-eater (*Myrmecobius fasciatus*) *See* Myrmecobiidae.

banded humbug (*Dascyllus aruanus*) *See* Pomacentridae.

banded knifefish (*Gymnotus carapo*) *See* Gymnotidae.

banded pygmy sunfish (*Elassoma zonatum*) *See* Balistidae.

bandfish *See* Cepolidae.

bandicoot *See* Perameloidea.

band-winged grasshopper *See* Acrididae.

Bangiales (class Rhodophyceae) Order of red algae which are fairly simple in their structural organization. Two common genera are *Bangia* and *Porphyra*; *Bangia* is filamentous and can live in freshwater and marine habitats, while *Porphyra* is membranaceous and is found in intertidal regions on temperate coasts. *See also* laver.

Bang's disease Contagious abortion of cattle: a form of brucellosis.

banjo catfish *See* Aspredinidae.

Banjosidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine fish which have a deep, compressed body, and fairly large eyes, the head showing a steep profile. The first dorsal fin, with 10 spiny rays, is separated by a deep notch from the second dorsal fin, consisting of 12 soft rays. The second of the three anal spines is much larger than the other two. Greenish along the back and silvery along the sides, *Banjos banjos* (30 cm) is of some commercial importance to local fisheries along the coasts of China and Japan.

bankfull discharge Maximum amount of discharge (usually measured in m^3/s) that a stream channel can carry without overflowing. Its frequency varies between streams, from a few times each year to once every few years. The water height at bankfull discharge is referred to as the 'bankfull stage'.

bankfull stage *See* bankfull discharge.

Banksia (family Proteaceae) Genus of shrubs and small trees, whose inflorescences are dense, stout, showy spikes of up to 1000 flowers, developing into woody cones of follicles, plus bracts and bracteoles. There are 50 species, which are quintessentially Australian.

banner cloud Motionless, flag-like cloud, commonly of lenticular, or lens-like, shape, forming to the lee (eddy zone) side of a hill or mountain peak. The cloud extends downwind in a strong current of humid air. Many distinctive mountain peaks (e.g. the Matterhorn and Table Mountain) are associated with a characteristic banner cloud. *See also* lee wave.

banyans Species of fig tree (*Ficus*) that have spreading crowns and descending prop roots. They commence life as epiphytes; then descending anastamosing roots strangle the trunk of the host tree. The Buddha attained enlightenment beneath a banyan, *F. religiosa*. The famous banyan in Calcutta Botanic Garden, *F. bengalensis*, dates from 1782 and is more than 300 m in circumference.

baobab (*Adansonia digitata*) *See Adansonia*.

Baptornis advenus Grebe-like, fish-eating bird from the Upper Cretaceous. *Baptornis* is recorded from N. America. Like modern divers, it had rather poorly developed wings. Described by Marsh in 1877, *Baptornis* is known only from disarticulated bones.

bar 1 Unit of pressure, equal to one million dynes per square centimetre. The pressure of the atmosphere at sea-level on average is very approximately one bar, or about 1013 millibars (the bar

commonly being divided into one thousand millibars). 2 Geomorphological term: (a) Low ridge of sand or shingle laid down by marine aggradation in shallow water adjacent to a coastline. There are several varieties: a bay bar joins the two flanks of a bay and may enclose a lagoon; an offshore or barrier bar runs parallel to a coastline and up to 40 km distant. (b) Rocky obstruction across a glaciated valley. *See* glacial stairway. (c) Lobate river bedform, typically constructed of gravel, often regularly spaced, and forming a riffle or shallow section. (d) Point bar: a low crescentic shoal on the convex side (inside) of a river bend, consisting of material that has been eroded from the outside bend either opposite or upstream. Point-bar deposits consist of gravel, pebbles, and boulders, often showing an upstream dip ('imbricate structure').

Baragwanathia longifolia During the Devonian and Carboniferous, the lycopsides or club mosses reached the peak in their diversification. *B. longifolia* was an early representative of the family Drepanophycaceae and is known from the Lower Devonian.

barat Local term for a fierce north-westerly wind common from December to February on the northern coast of Celebes.

barbel Fleshy protuberance near the mouth of some fish, especially suctorial feeders, e.g. sturgeons and catfish. Basically a sensory structure, it is provided with tactile and chemical receptor cells, and is therefore useful in the location of food.

barbel-less catfish *See* Ageneiosidae.

barberry *See Berberis*.

barbets *See Capito*; Capitonidae; *Lybius; Megalaima*; and Piciformes.

Barbula (order Pottiales) Large genus of mosses, species of which are not always easy to distinguish. The plants are mostly small, forming tufts, cushions, or short turfs. Leaves may be blunt or pointed, but lack the hair-point typical of the related genus *Tortula*. Capsules are cylindrical and erect, with an oblique, beaked lid; the peristome has short, straight teeth in some species (e.g. *B. tophacea* and *B. recurvirostra*) and long, twisted teeth in others (e.g. *B. fallax*, *B. unguiculata*, and *B. convoluta*). There are about 500 species, occurring mainly in temperate regions, and found on the ground, on walls, on garden paths, etc.

Barbus tetrazona (tiger barb) *See* Cyprinidae.

Barbus tor (mahseer) *See* Cyprinidae.

barchan Crescent-shaped mobile dune in a sand desert in which the wind blows predominantly from one direction. It moves by erosion of sand from the windward slope, and accumulation on the steeper lee or slip slope which stands at about 32°. Average velocities of dune movement are 10–20 m/yr.

Barclaya (family Nymphaeaceae) Genus of water lilies which produce large, solitary flowers, with an inferior ovary. There are three or four species, found in damp places on the floor of Indo-Malaysian tropical rain forests.

barite (barytes) Mineral, specific gravity 4.3–4.6, hardness 3.0–3.5, chemical composition $BaSO_4$, whose name is derived from the Greek for 'heavy'. It occurs as a vein filling, and also as a gangue mineral with ores of lead, copper, zinc, silver, iron, and nickel, associated with calcite, quartz, fluorite, dolomite, and siderite. It is a low-temperature mineral which also occurs as a replacement for limestone, and as a cement in sandstone. It is distinguished by its high specific gravity, cleavage, and insolubility in acid. It is colourless to white, often tinged yellow, brown, blue, green, and red, with a white streak and a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are commonly tabular, prismatic, fibrous, and lamellar, and often granular. It is used as a weighting agent in drilling muds; in the chemical industry; in the manufacture of rubber, paper, and high-quality paints; and as an X-ray absorbant.

bark Outer skin of a tree trunk, outside the secondary, vascular, cambium. It is composed of phloem tissues, which occur as living inner and dead outer zones. The outer zone is penetrated by the cork layers (or periderms) formed from cork cambia (or phelloderms), and is sometimes called the rhytidome. The bark surface is variously sculptured, e.g. smooth, scaly or fissured; and these surface features are partly determined by the arrangement of the phloem tissues and periderms.

bark beetle *See* Scolytidae.

barkbug *See* Aradidae.

barley yellows Virus disease of barley and other cereals in which infected plants are stunted and yellow in colour. The virus is transmitted by aphids.

barnacles 1 *See* Cirripedia; Crustacea; and Thoracica. 2 (acorn barnacles) *See* Balanidae. 3 (goose barnacles) *See Lepas anatifera*; and Lepadidae. 4 (parasitic barnacles) *See* Rhizocephala; and *Sacculina carcini*.

barn owls *See Tyto*; and Tytonidae.

barn swallow (*Hirundo rustica*) *See Hirundo*.

baroclinic 1 Applied to an atmospheric condition in which isobaric and constant-density surfaces are not parallel, e.g. in a frontal zone. *Compare* barotropic. 2 Applied to a state in the ocean in which the surfaces of constant pressure intersect surfaces of constant density.

baroduric Capable of withstanding high pressures.

barograph Barometer that gives a continuous recording of air pressure. It is based on an aneroid instrument with levers attached to the vacuum chambers, and records a trace on a chart mounted around a clock drum.

barometer Instrument for the measurement of atmospheric pressure. The usual type is a mercury barometer, in which the atmosphere's pressure on a small reservoir of mercury supports a column of mercury in a vacuum tube the open end of which is below the surface of the mercury in the reservoir. The column is on average about 76 cm (30 inches) high. Readings must be corrected to compensate for

pressure variation due to gravitational anomalies and for thermal expansion or contraction of the mercury, therefore correction to a standard temperature is necessary. *See also* aneroid barometer; Fortin barometer; and Kew barometer.

barophilic Living in or preferring environments subject to high pressures, e.g. deep-sea environments.

barothermograph Device for the continuous measurement of both pressure and temperature, on a revolving chart.

barracuda *See* Sphyraenidae.

barracudina *See* Paralepididae.

barramundi, spotted (*Scleropages leichardti*) *See* buccal incubation; and Osteoglossidae.

Barrandeoceratida (class Cephalopoda, subclass Nautiloidea) Order of cephalopods which display a range of morphology, although many early members resemble the coiled Tarphyceratida. The position of the siphuncle is also variable. There are no cameral or siphuncular deposits. The order ranges in age from Middle Ordovician to Middle Silurian.

Barr body The condensed single X-chromosome, appearing as a densely-staining mass, found in the nuclei of somatic cells of female mammals. It is named after its discoverer, Murray Barr. It is derived from one of the two X-chromosomes, which becomes inactivated. The number of Barr bodies is thus one less than the number of X-chromosomes. Barr bodies are commonly referred to as sex chromatin. The human abnormalities called Kleinefelter's syndrome and Turner's syndrome both result from an unnatural presence or absence of a Barr body. In the case of the former, the male possesses a Barr body that he would normally not have, and in the latter case the Barr body is absent.

barreleye *See* Opisthoproctidae.

barren Community of few and scattered plants that occupy less than half the available ground area. Barrens occur within the arctic tundra, typically dominated by a single plant species e.g. *Dryas octopetala* (mountain avens); and often a single particle-size predominates in the soil.

barrier bar Offshore bar of gravel or sand that is parallel to the shoreline and whose crest rises above the high-water level.

barrier island Segmented barrier-bar complex found between two tidal inlets. Barrier-island systems have a lagoonal area on their landward side, and often have dunes and vegetation on the exposed barrier. There are three main hypotheses to explain the origin of barrier islands: (a) the building up of submarine bars; (b) spit progradation parallel to the coast and segmentation by inlets; and (c) submergence of subaerial coastal beach ridges by a rise in sea-level. Barrier islands are most common in areas of low tidal range.

barrier reef Reef trending parallel to, but separated by a lagoon from, a shore. The reef-building organisms build up the structure to approximately the low-tide level. One of the finest examples is the Great Barrier Reef which lies off the NW coast of Australia: it extends for about 1900 km and is 30–160 km in width. *See* reef.

Barringtonia (family Lecythidaceae) Genus of mostly small tropical trees whose flowers are nocturnal, sweet-scented, borne in spikes, and often cauliflorous. They have many stamens, and the ovary is inferior. The fruits are indehiscent, with one seed. *B. asiatica* is a widespread species found along sandy coasts. There are 40 species, occurring in Africa, Madagascar, and from Indo-Malaysia to the Pacific.

Barringtoniaceae Group of plants which includes the genus *Barringtonia* and which formerly was regarded as a separate family, but all of whose genera are now placed within the family Lecythidaceae.

Bartonellaceae (order Rickettsiales) Family of bacteria which are parasitic in vertebrate hosts, usually within the red blood cells. They can be cultivated in cell-free media in the laboratory. They can cause disease in humans. There are two genera.

barytes *See* barite.

basal body Structure located in the cytoplasm of cells, from which cilia and flagella project. Normally it is composed of nine sets of microtubules, each set arranged in triplets, embedded in a dense, granular matrix.

basal bristle Small modified feather with little or no vane found at the base of the bill in birds. *See also* rictal bristle.

basal lamina (basement membrane) Amorphous, or filamentous, sheet of material underlying epithelial cells. It is composed of a special kind of collagen and a carbohydrate.

basalt Fine-grained, basic, volcanic-igneous rocks which are frequently dense, and black in colour. They contain small crystals of plagioclase feldspars, pyroxene, and magnetite, and sometimes larger crystals of pyroxene and olivine. Basalt flows are fluid or mobile in character and are not usually associated with explosive activity. Some ancient flows are known to cover vast areas and to form distinctive plateau lands, hence the term 'plateau basalts'.

base According to the Brønsted–Lowry theory, a substance that in solution can bind and remove hydrogen ions or protons. The Lewis theory states that it is a substance that acts as an electron-pair donor. A base reacts with an acid to give a salt and water (a process called neutralization) and has a pH greater than 7.

base analogue Purine or pyrimidine base that differs slightly in structure from the normal base, but that because of its similarity to that base may act as a mutagen when incorporated into DNA. Once in place, these bases, which have pairing properties unlike those of the bases they replace, can produce mutations by causing insertions of incorrect nucleotides opposite them during replication. Though the original base analogue exists

only in a single strand, it can cause a nucleotide-pair substitution that is replicated in all DNA copies descended from that original strand. An example is 5-bromo-uracil (5BU), an analogue of thymine that has bromine at the C_5 position in place of the CH_3 group found in thymine.

base level A theoretical plane surface underlying a land mass, denoting the depth below which erosion would be unable to occur. Sea-level provides a base level on a regional scale. Local base levels may be provided by the base of a hillslope, or by the junction between a tributary and the main river.

Basella (family Basellaceae) Small genus of tropical herbs, related to Chenopodiaceae, with a swollen, perennial, underground stem annually producing twining shoots. *B. alba* (Indian spinach) is cultivated throughout the tropics for these shoots.

basement membrane *See* basal lamina.

base pairing Complementary binding by means of hydrogen bonds of a purine to a pyrimidine base in nucleic acids. In DNA, such binding occurs between cytosine and guanine, and between adenine and thymine; while in RNA uracil substitutes for thymine.

base saturation Expressed as a percentage of the total cation-exchange capacity, the extent to which the exchange sites of the soil's adsorption complex are 'saturated' (or occupied) by exchangeable basic cations, or by cations other than hydrogen and aluminium.

basic dye Dye consisting of an organic cation that combines with and stains negatively charged macromolecules, e.g. nucleic acids. It is used particularly for staining cell nuclei which contain nucleic acids.

basic grassland Vegetation pattern that occurs on soils with an alkaline reaction, particularly those developed in chalk or limestone. In Britain, and NW Europe generally, basic grasslands include some of the oldest areas of rough grazing, dating from Neolithic times. Floristically they are comparatively diverse and there are numerous characteristic herbs other than grasses.

basic rock Rock with a relatively high concentration of iron, magnesium, and calcium, and with 45–53% of silica by weight. Examples include gabbro and essexite, which are coarse-grained basic intrusive rocks. Basalt is a fine-grained basic volcanic rock.

basic soil A soil with a pH greater than 7.0. *See* alkaline soil.

basidiocarp The fruit body of a basidiomycete.

basidiolichen Any lichen in which the mycobiont is a basidiomycete.

basidiomycete Fungus that belongs to the subdivision Basidiomycotina.

Basidiomycotina (division Eumycota) Subdivision of fungi in which the sexually-produced spores are basidiospores. The subdivision includes most of the familiar macroscopic fungi, including mushrooms, toadstools, bracket fungi, etc. There are three classes. Most are saprotrophic, but some are parasitic on plants.

basidiospore Sexually-produced spore, borne on a basidium in a fungus of the Basidiomycotina.

basidium Microscopic structure upon which sexually-produced spores are formed externally. Basidia are characteristic of fungi of the Basidiomycotina.

basifugal movement *See* acropetal movement.

Basileuterus (wood-warblers; family Parulidae) Genus of small warblers, brown above and yellow below, most with coloured head stripes. They inhabit forest undergrowth, are insectivorous, and build a domed nest with a side entrance on or near the ground. There are 21 species, found in C. and S. America.

Basiliscus (basilisks; order Squamata, suborder Sauria (Lacertilia), family Iguanidae) Genus of arboreal, iguanid lizards which are fast, bipedal runners on land, and also over the surface of water! They are excellent swimmers. Adults develop a casque on the head, which is larger in males. They feed on fruit and small animals. They occur in Mexico and Ecuador.

basilisks *See Basiliscus*; and Iguanidae.

Basilosaurus Whales first appeared in the Eocene. They most likely arose from a group of carnivores during the Palaeocene, and the earliest forms possessed large saw-edged teeth. These were called archaeocetes, and *Basilosaurus* is one of the best-known forms. It grew to approximately 20 m in length and lived during the Upper Eocene.

basin Depression, usually of considerable size, which may be erosional or structural in origin. The converse of a dome.

basin-and-range province 1 Specifically, the structural subdivision of the western USA between the Colorado Plateau to the west and the Sierra Nevada to the east. It is dominated by a series of block-faulted ranges and troughs which dissect it, rising above bajadas and alluvial plains which mask down-faulted units. Frequently the ranges are tilted blocks approximately 30–40 km across. Movement occurred initially in Miocene times, and then during the late Pliocene to Recent. 2 Generally, applied to landscapes having a series of tilted fault blocks that form long, asymmetric ranges separated by broad basins.

basipetal Growing or developing from apex to base, so that the oldest parts are nearest the apex and the youngest are nearest the base.

basipetal movement Movement of substances toward the basal region of the plant from the root and shoot apices. *Compare* acropetal movement.

basitarsus First tarsal segment in the leg of an insect, which articulates with the tibia proximally, and with the other tarsal segments, or tarsomeres. *See also* tarsus.

basking shark (*Cetorhinus maximus*) *See* Lamnidae.

Basommatophora (class Gastropoda, subclass Pulmonata) Order of pulmonate gastropods that are predominantly aquatic, certain groups of which have secondary gills. Eyes are present at the base of a single pair of tentacles. The order first appeared in the Mesozoic.

basophilic Applied to a cell, its components, or products that can be stained by a basic dye.

bass 1 (fish) *See* Serranidae. 2 (bot.) *See* raffia-fibre.

Bassia (family Chenopodiaceae) One of the 13 genera of chenopods that are endemic to Australia. The genus comprises 48 species of small shrubs, found mainly in the arid and littoral zones on lime-rich and saline soils, e.g. the Nullarbor Plain.

Basslerocerati da (class Cephalopoda, subclass Nautiloidea) Order of straight or curved, cyrtoconic cephalopods in which the siphuncle is normally ventrally placed and of medium size. The conch is compressed. Lobate sutures are common. The order is restricted to rocks of Ordovician age.

basslet (*Gramma loreto*) *See* Grammidae.

bast Raffia-fibre.

bastard trumpeter (*Latriodopsis forsteri*) *See* Latridae.

bat *See* Chiroptera.

Batesian mimicry Mimicking of brightly coloured, or distinctively patterned, unpalatable species by palatable species. This helps protect the mimics from predators.

batfish *See* Ephippidae; and Ogcocephalidae.

batholith Large (more than 100 km^2) igneous intrusion, which may comprise several plutons amalgamated at depth. Most batholiths are granitic in composition and their genesis is linked with plate tectonics. Generally, batholiths cut across country rocks and therefore are discordant in nature.

Bathonian Middle Jurassic stage commonly represented by carbonate sediments in many areas of Europe. It is known to contain an abundant fauna of invertebrates including the oyster *Catinula knorri*.

bathyal zone Oceanic zone at depths of 200–2000 m, lying to the seaward of the shallower neritic zone, and landward of the deeper abyssal zone. The upper limit of the bathyal zone is marked by the edge of the continental shelf. In marine ecology, it is the region of the continental slope and rise. It may be geologically active, and include trenches and canyons, with underwater erosion producing avalanches.

Bathyclupeidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of deep-sea fish found in tropical waters. The mouth gape of these silvery, deep-bodied, large-eyed fish is in an almost vertical position. Physically fragile, these midwater fish are found at depths of about 500 m. There are about four species.

Bathydraconidae (dragonfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of mainly deep-water antarctic fish with a flattened head, tapering body, and rounded tail-fin. Some individuals have been caught at depths exceeding 2000 m. There are about 15 species.

Bathydraco scotiae (dragonfish) *See* Bathydraconidae; and bathypelagic fish.

Bathyergidae (mole rats; order Rodentia, suborder Hystricomorpha) Family of mole-like rodents that live in shallow tunnels. Most of the hair is lost, the legs are short, strong, and pentadactyl, with strong claws. The skull is short and strong, with occipital and sagittal crests prominent, and paroccipital processes short. The cheek teeth are hypsodont, and rooted. The teeth are reduced in number. The animals are distributed throughout Africa south of the Sahara. There are about 22 species, in five genera.

Bathylagidae (deep-sea smelts, black smelts; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of small (15 cm) open-ocean fish with large eyes, a small mouth, and varying body shape. Probably they undertake vertical migrations between different ocean depths. There are about 35 species.

Bathymasteridae (searcher, ronquil; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine coastal fish of the N. Pacific. The seven known species have a somewhat slender body with long dorsal and anal fins, and do not exceed 30 cm in length.

bathymetry Measurement of ocean depths.

bathypelagic fish Deep-sea fish living at depths of 1000–3000 m, where the environment is uniformly cold and dark. A swim-bladder is often absent, but many species—e.g. *Bathydraco scotiae*, dragonfish and *Chiasmodon niger*, swallower—possess photophores or luminous organs.

Bathypteroidae (class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of mainly deep-water, bottom-living fish. They are distinguishable by a flattened head, minute eyes, slender body, and very long first pectoral and pelvic fins, the latter being used occasionally to 'walk' over the sea bottom. There are about eight species, including *Bathypterois longipes*.

Batoidea Older name for the group or order of fish comprising the rays and skates. *See also* Rajiformes.

Batoidimorpha (class Chondrichthyes, subclass Elasmobranchii) Superorder of living and fossil cartilaginous fish, including all rays and skates.

Batrachoididae (toadfish; class Osteichthyes, subclass Actinopterygii, order Batrachoidiformes) Fairly large family of bottom-dwelling, inshore marine fish of tropical and subtropical waters. They have a wide (toad-like) mouth; a large head with dorsally-positioned eyes; a short, stout body; and small gill openings. Some species, e.g. *Opsanus tau*, can produce underwater sounds by means of special muscles acting on the wall of the swim-bladder. There are about 55 species.

Batrachoidiformes (class Osteichthyes, subclass Actinopterygii) Order of marine bony fish, characterized by large heads, dorsally-positioned eyes,

a wide mouth, and pelvic fins in the jugular position. The order includes the various types of toadfish. *See also* Paracanthopterygii.

Batrachostomus (frogmouths; family Podargidae) Genus of grey-brown, cryptically-coloured, nocturnal birds, with large, wide bills. They are arboreal and insectivorous, picking insects off branches and the ground. Their nest is a pad of down secured to a horizontal branch. There are 10 species, found in India, SE Asia, Indonesia, and Malaysia.

batrachotoxin *See Dendrobates*.

Bauhinia (family Leguminosae, subfamily Caesalpinadeae) Genus of plants, most of which are woody climbers with curiously flattened, or corrugated, stems. A few are small trees. The flowers are very showy. The leaves are simple, more or less split into two lobes, with many main veins. Because of the bilobed leaves, the genus is named in honour of the Bauhin brothers, Jean (1541–1613) and Gaspard (1550–1624), French botanists who were also physicians and who were among the earliest workers to attempt a comprehensive taxonomic classification of plants. There are 300 species of *Bauhinia*, distributed through the tropics and subtropics.

bauk *See* balk.

baulk *See* balk.

baumgrenze A line, through the last of the stunted trees, marking the limit of a zone of stunted tree growth (such as is often found near the upper limits of tree growth, above the elevations at which trees grow uniformly erect and in forest densities). The individual trees are sparsely scattered, and prostrate, or almost so.

bavin In southern England, the name given to a small piece of wood, produced by brashing trees. Bavins may be sold in faggots for kindling. *See also* spray.

bay bar *See* bar.

bay-head beach Sand or shingle beach in the low-energy environment at the head of a bay. It is typical of irregular coastlines in which bays and promontories alternate.

bay laurel (*Laurel nobilis*) *See Laurel*.

bay lynx (bobcat, *Lynx rufus*) *See Lynx*.

bay owls *See* Tytonidae.

bay-winged cowbird (*Molothrus badius*) *See Molothrus*.

BCG (bacille Calmette–Guerin) Strain of *Mycobacterium bovis* used in a vaccine against tuberculosis and leprosy.

Bdelloida (phylum Aschelminthes, class Rotifera) Order of freshwater, aschelminth worms, which have slender, jointed bodies, and a free-swimming mode of life. The cuticle may bear longitudinal depressions. There are no males present in this order.

Bdellonemertini (phylum Nemertini, subclass Anopla) Order of nemertinid worms that possess a relatively simple proboscis. All have a contorted intestine.

Bdellovibrio Genus of Gram-negative bacteria which is not assigned to any taxonomic family. The cells are small, curved rods, usually motile with a single flagellum at one end. They are aerobic. They parasitize other bacteria by penetrating them, and then growing and dividing within them. They are found in soil, in freshwater and marine habitats, and in sewage, etc.

beach Accumulation of sand and gravel found at the landward margin of the sea or a lake. Upper and lower limits approximate to the position of highest and lowest tidal water levels. The angle of slope and the sedimentary structures of a beach are related to the grain size of the beach materials, and to the nature of wave activity and other sedimentary processes active in the area.

beach cusp One of a series of regularly-spaced crescent-shaped structures forming local relief along a beach face. The horns or 'headlands' of the cusp are composed of coarse sand or gravel, and point seaward down the beach. The intervening troughs or 'bays' are made up of finer sand. The height of beach cusps is usually in the order of several centimetres, although larger examples have been described. The size and spacing of cusps appears to be related to the nature of waves breaking on the beach.

beach flea *See* Amphipoda.

beach hopper (*Talitrus*) *See* Amphipoda.

beach rock Cemented beach sand deposit that develops within the intertidal zone by the precipitation of needle-like crystals of aragonite in the pore space between the grains. The cementation process is relatively rapid, taking as little as 10 years for a lithified rock to develop. The precipitation of the cement is favoured by a warm climate, and may be aided by algal or bacterial action.

beach salmon *See* Leptobramidae.

beaded lightning *See* pearl-necklace lightning.

beaded lizard *See* Helodermatidae.

beak 1 Rigid cylindrical or conical projection on the tip of a fruit (as in *Geranium*). 2 Projection in Orchidaceae that separates the anther from the stigmatic surface below it in the flower. 3 The bill of a bird.

bean gall Red or pink, kidney-bean-shaped gall, found on the leaves of *Salix* species (willow) and caused by the small sawfly, *Pontania proxima* (family Tenthredinidae). A second brood laid in the early autumn by the adults that emerged in summer may overwinter in the gall. Sometimes the term 'bean gall' is used more generally to describe any red or brown gall caused by any *Pontania* species. Many galls may occur on a single leaf and, like other gall-causing species, the insects support a large community of parasites and hyperparasites.

bean weevil (*Sitona lineatus*) *See* Curculionidae.

bearded dragon *See Amphibolurus barbatus*.

bearded lizard *See Amphibolurus barbatus*.

bearded reedling (*Panurus biarmicus*) *See* Paradoxornithidae.

bearded tits *See* Paradoxornithidae.

beardfish *See* Polymixiidae.

beardie (*Lotella callarias*) *See* Moridae.

beard lichen Common name for the tufted, hair-like thallus of a lichen of the genus *Usnea*.

bears *See* Ursidae.

bear's breeches (*Acanthus mollis*) *See Acanthus*.

beat up Replace dead trees with new ones, especially during the early years of the establishment or re-establishment of a plantation.

Beaufort scale Scale of values, from 0 to 12, for describing wind strength, as defined by Admiral Beaufort in the nineteenth century. Each wind force is recognized by its common effects on objects in the landscape (dust, flags, trees, etc.) and on people in the open, or on the state of the sea surface.

Beaumontia (family Apocynaceae) Genus of woody climbers with handsome flowers, which are sometimes cultivated. There are 15 species, occurring from China to India and Java.

beaver *See* Aplodontidae; and Castoridae.

becards *See Pachyramphus*.

bedbug *See Cimex lectularius*.

bedding (geol.) Layering of sheet-like units, called beds or strata; a bed or stratum being the smallest distinguishable division within the classification of stratified sedimentary rocks. Cross-bedding is a type of stratification in which some sediment layers have an inclined attitude in relation to those immediately above or below.

bedding plane Well-defined, planar surface that separates one bed from another in sedimentary rock. Each plane marks a break in deposition.

Bedfordia (family Compositae) Genus of two species of plants endemic to the southern states of Australia.

bedload (traction load) The coarser fraction of a river's total sediment load, which is carried along the bed by sliding, rolling, and saltation. It constitutes 5–10% of the total load.

Bedsonia Obsolete genus of bacteria now included in the genus *Chlamydia*.

bee bread Mixture of pollen, honey, and in some species plant oils and Dufour's gland exudates, that comprises the food of bee larvae.

beech *See Fagus*.

beech-bark disease Disease of beech trees (*Fagus*) caused by a variety of *Nectria coccinea*. Symptoms include yellowing of foliage and die-back; infected trees may be killed. The disease is spread from tree to tree by scale insects.

bee dance Sequence of movements by which workers of certain bee species, most notably *Apis mellifera* (honey bee), inform other members of the hive of the existence and location of a source of food. *See also* dance language.

bee-eaters *See* Meropidae; *Merops*; and Coraciiformes.

bee-flies *See* Bombyliidae.

beefsteak fungus Common name for the fruit body of *Fistulina hepatica*. The flesh is red-brown with a gelatinous upper surface, and yields a reddish juice; spores are formed within tubes which open via pores on the pale underside of the fruit body. It is parasitic on trees, particularly oak. It is fairly common in late summer and autumn. *See also Fistulina*.

bee hummingbird (*Mellisuga helenae*) *See* Trochilidae.

bee lice *See Braula caeca*; and Braulidae.

bees 1 *See* Apidae; Apocrita; Hymenoptera; and Sphecoidea. 2 (Old World carpenter bees, *Xylocopa*) *See* acarinum. 3 (tawny mining bee) *See Andrena fulva*. 4 (solitary mining bees) *See* Andrenidae.

beeswax Wax secreted from glands beneath the abdominal terga or sterna of bees of the family Apidae (orchard bees, bumblebees, stingless bees, and honeybees), which is used in nest construction.

beetle-hunting wasp *See* hunting wasp.

beetles *See* Coleoptera.

beetroot (*Beta*) *See* Chenopodiaceae.

beet yellows Virus disease of sugarbeet, beetroot, etc. The leaves of infected plants become reddish-yellow, dry, and brittle. The virus is transmitted by aphids.

Beggiatoaceae (order Cytophagales) Family of gliding bacteria which form colourless, flexible, sheathed filaments. The sheath may enclose a single filament (e.g. in *Beggiatoa*), or bunches of filaments (in *Thioploca*). They are aerobes or micro-aerophiles. Some genera form granules of sulphur inside their cells when grown in the presence of hydrogen sulphide. They are found in marine or freshwater habitats.

Begoniaceae Family of mostly succulent herbs or undershrubs, which are almost entirely tropical. The stems are pointed, with alternate simple, often unequal-sided leaves. They are monoecious, and the flowers are usually irregular, borne in cymes, and showy. There are two (to five) free sepals and petals, and many stamens in the male flower; and the ovary is usually inferior. The fruit is a capsule, or berry. *Begonia* is much cultivated, but is not hardy in climates with frosty winters.

Beilschmiedia (family Lauraceae) Genus of small to medium trees, some yielding ornamental timber. There are 200 species, occurring in the tropics, Australia, and New Zealand.

Bejaudia (family Palmae) Genus of climbing palms (rattans), in which the leaf sheath is spiny, and inflorescences may be terminal. There is one little-known species in Indo-China.

belemnites *See* Belemnoidea.

Belemnoidea (belemnites; class Cephalopoda, subclass Coleoidea) Order of extinct cephalopods which had an internal shell composed of phragmacone, a rostrum, and a pro-ostracum. There are five families. They appear in Upper Carboniferous rocks and persist generally until the end of the Cretaceous, and in one area into the Eocene.

belian (Borneo ironwood, *Eusideroxylon zwageri*) *See Eusideroxylon*.

bellflowers (*Campanula*) *See* Campanulaceae.

Belliolum (family Winteraceae) Genus of small trees in which the flowers are white, with numerous petals and stamens, and one or a few free carpels. There are eight species, occurring in the Solomon Islands and New Caledonia.

bell morel Common name for the fruit body of the ascomycetous fungus *Verpa conica* (order Pezizales). It is rare in Britain.

bell moths *See* Tortricidae.

bellowsfish *See* Macrorhamphosidae.

Belonidae (garfish, long tom, needlefish; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Family of mainly marine, tropical and subtropical fish with very long, slender bodies, beak-like jaws, and dorsal and anal fins placed close to the tail-fin. Often swimming in schools, they are known to leap out of the water when frightened. *Tylosurus crocodilus* (houndfish) is probably the largest of the 26 or so species.

Belontiidae (gourami, labyrinth fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of small, freshwater fish, characterized by a protrusible upper jaw, vestigial lateral line, ten or fewer soft rays in the dorsal fin, and often an elongate pelvic ray in the jugular pelvic fins. Labyrinth-like accessory breathing organs can be found in the gill chambers. Prior to spawning, males often make a foamy bubble nest at the surface of the water. The many species popular with aquarium hobbyists include the Siamese fighting fish (*Betta splendens*), the paradise fish (*Macropodus opercularis*) and the thicklip gourami (*Colisa labiosa*). They are indigenous to Africa and S. Asia.

Belostomatidae (order Hemiptera, suborder Heteroptera) Family of large, aquatic bugs, which are ferocious predators of small fish and frogs as well as of invertebrates, seizing their prey with the front pair of legs. The family includes some of the largest aquatic insects. They are often attracted to artificial light. They occur mainly in the tropics.

beluga (white whale, *Delphinapterus leucas*) *See* Monodontidae.

Bembix *See* Sphecidae.

Bengalese finch (*Lonchura striata*) *See Lonchura*.

Bengal swamp eel (*Synbranchus bengalensis*) *See* Synbranchidae.

Benguela current Oceanic water current that flows northward along the west coast of southern Africa between latitude 15° S and 35° S. It is distinguished by an area of cold upwelling water, and is a relatively weak current flowing at less than 25 cm/s.

Bennettitales Extinct gymnosperm order ranging from the Triassic into the Cretaceous. They resembled cycads, and possessed reproductive structures which must have looked more like flowers than cones.

ben oil *See Moringa*.

benthic fish Fish that live on or near the sea-bottom: the term is used irrespective of whether the sea is shallow or deep. Many species (e.g. gurnard) possess modified fins, enabling them to crawl over the bottom; others (e.g. flounder and ray) have flattened bodies and can lie on the sand. Weed beds, rocky outcrops, and coral reefs provide living space for another group of benthic fish, including damselfish, moray eels, and triggerfish.

benthos (adj. benthic) In freshwater and marine ecosystems, the collection of organisms attached to or resting on the bottom sediments.

Bentinckia (family Palmae) Genus of palms in which the trunk is solitary, and hoop-marked. The leaves are pinnate, with a long crown-shaft, below which appear the much-branched inflorescences. *B. nicobarica* is widely cultivated. There are two species, one native to India, and the other to the Nicobar Islands.

bentonite Montmorillonite-rich clay formed by the breakdown and alteration of volcanic ash and volcanic tuffs.

benzoin *See Styrax*.

Berberidaceae Family of herbs and shrubs, in whose flowers the perianth is regular, tri- or dimerous, and composed of free parts in 2–7 whorls, the whorls being either alike or different. The ovary consists of a single carpel, forming a berry or capsule. There are ten genera, and some 300 species, mainly confined to the northern temperate zone (but *Berberis* is almost cosmopolitan).

Berberis (barberry; family Berberidaceae) Genus of spiny, simple-leaved shrubs producing flowers which are trimerous, with spines in threes, the perianth usually consisting of five yellow or orange whorls. The fruit is an edible berry. They are much cultivated for ornament, and formerly were grown for their edible fruits. They are a secondary host of wheat rust, so are often eliminated in wheat-growing areas. There are more than 200 species, of cosmopolitan distribution in temperate zones and in the mountains of tropical Africa.

Bergen School Name used to distinguish the group of meteorologists (V. Bjerknes, J. Bjerknes, H.Solberg, and T. Bergeron) who, working in Norway between 1917 and 1920, established the existence and role of fronts and air masses in the atmosphere.

Bergeron theory (Bergeron–Findeisen theory) A theory, proposed around 1930 by T. Bergeron, and subsequently developed by W. Findeisen, that provides a mechanism for the growth of raindrops

in ice/water cloud. It is based on the differential values for saturation vapour pressure over ice and supercooled-water surfaces. At cloud temperatures of −12 to −30 °C air can be saturated over ice but not over water particles, so evaporation can take place from the water drops, and ice particles can grow by sublimation at the expense of water droplets. When they are large enough, the ice particles can fall from the cloud. The process depends on there being a mixture of ice and water, and so may operate in mid- and high-latitude cloud, but not in all clouds, e.g. not in tropical clouds which are at temperatures above freezing. *See also* collision theory; and ice nucleus.

Bergmann's rule The idea that the size of homoiothermic animals in a single, closely-related, evolutionary line increases along a gradient from warm to cold temperatures—i.e. that races of species from cold climates tend to be composed of individuals physically larger than those of races from warm climates. This is because the surface-area : body-weight ratio decreases as body weight increases. Thus a large body loses proportionately less heat than a small one. This is advantageous in a cold climate but disadvantageous in a warm one.

berg wind Local wind, generically of the föhn type, which blows offshore in S. Africa.

Beringia Area comprising the Bering Strait and adjacent Siberia and Alaska. At various times in the late Mesozoic and Cenozoic, the Strait was dry land and so provided for plants and animals an important migration route between the Palaearctic and Nearctic biogeographical regions.

Bering land bridge *See* land bridge.

berm Ridge or nearly flat platform at the rear of a beach and standing just above the mean high-water mark. Its distinguishing feature is a marked break of slope at the seaward edge.

Bermuda buttercup (*Oxalis cernua*) *See Oxalis*.

Bermuda high Anticyclonic cell in the Bermuda region as a westward extension to, or displacement of, the Azores high-pressure system.

Beroida *See* Beroidea.

Beroidea (Beroida; class Nuda) Order of ctenophorids which are mainly cylindrical in shape. The body contains a very large mouth. Tentacles do not occur at any stage in development.

berry Fleshy, indehiscent, many-seeded fruit containing no hard parts except the seeds. A banana is a berry.

Berrya (family Tiliaceae) Genus of trees which have fibrous bark and which yield valuable timber. There are six species, occurring in open places from Indo-Malaysia to the Pacific.

Bertholletia (family Lecythidaceae) Genus of two species of big, locally common, rainforest trees of tropical America. *B. excelsa* is the brazil-nut. The fruit is a hard, spherical, woody capsule opening by a terminal plug and containing numerous very hard, woody seeds with copious, oily endosperm.

Berycidae (alfonsinos; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of marine, offshore fish. They are deep-bodied fish with strongly-forked tails, large eyes, and often a reddish skin indicative of fish living at moderate depths. In temperate Australia *Trachichthodes affinis* (nannygai) are trawled commercially and are sometimes sold as 'redfish'. There are about 10 species, with worldwide distribution.

Beryciformes (class Osteichthyes, subclass Actinopterygii) Order of bony fish, most with short, deep bodies, rough scales, sharp spines on the head, and usually more than five soft rays in the ventral fins. With more than 140 species, this order is divided into several suborders, e.g. Berycidae (alfonsinos), Holocentridae (squirrel-fish), Anomalopidae (lantern-eye fish).

beryl Accessory mineral, specific gravity 2.6–2.8, hardness 7.5–8.0, and with the chemical composition $Be_3Al_2Si_6O_{18}$. It is found extensively in granites, pegmatites, and also in mica schists and gneisses. It is found in cavities, and is associated with rutile. It is distinguished by its hexagonal crystal form, its green colour, and its hardness which is greater than that of apatite. It is normally green—but can be blue, yellow, or pink—and translucent to transparent, with a vitreous lustre. It crystallizes in the hexagonal system. The crystals are hexagonal prisms, often striated, and also massive. It is an ore mineral for beryllium. Transparent green minerals are used as emeralds, bluish-green as aquamarine, and pink as morganite.

Beta (beetroot, sugar beet) *See* Chenopodiaceae.

beta-galactosidase Inducible enzyme responsible for the catalytic hydrolysis of beta-galactoside.

beta-galactoside Glycoside formed from the beta-stereoisomer of galactose.

beta-mesohaline *See* brackish.

betel-nut *See Areca*.

Bethylidae (suborder Apocrita, superfamily Bethyloidea) Family of small to medium-sized wasps (usually less than 8 mm long), which are usually black, with an elongate head, and slightly elbowed, 12- or 13-segmented antennae. The wing venation is reduced, and the hindwing has a jugal lobe. The females of many species are apterous and ant-like, and a few will sting. The habits of the family are very diverse, but in most cases no true nest is made; rather the host larva (a small lepidopteran or coleopteran) is dragged to a sheltered location where more than one egg may be laid. The larvae are external parasites, and having matured will spin a silken cocoon. Adults may be collected from tree trunks or leaf litter, but these wasps are seldom encountered. The Bethylidae is often considered to represent an intermediate condition between true parasitoid and fossorial (burrowing) families.

betle pepper (*Piper betle*) *See Piper*.

Betta splendens (Siamese fighting fish) *See* Belontiidae.

Betula (birches; family Betulaceae) Genus of fast-growing and light-demanding trees, some of which provide valuable, pale timber. Male flowers are borne in catkins, female flowers in clusters; and

there is no perianth. The fruit is a small, winged nut. There are 60 species, occurring in the northern temperate, and arctic regions.

Betulaceae Family of deciduous shrubs and trees in which the leaves are simple, with stipules. The flowers are unisexual, the males borne in catkins, with 2–12 stamens; the females clustered, the ovary inferior and composed of two fused carpels. They are wind-pollinated in early spring. The fruit is a one-seeded nut, often winged. The family includes the birches (*Betula*), alders (*Alnus*), hornbeams (*Carpinus*), and hazels (*Corylus*). There are six genera and 170 species occurring in the northern hemisphere, extending to the Himalayas and Andes.

Beyeria (family Euphorbiaceae, tribe Stenolobeae) Genus of 15 species of shrubs, endemic to Australia. They are found in areas of aridity and low fertility.

Bibio marci (St Mark's fly; suborder Nematocera, family Bibionidae) Fly that is usually found around St Mark's Day (April 25), and which is easily recognized as a large, heavy-looking, hairy, black fly that flies sluggishly. Care should be taken with identification, however, because of the large number of similar species that fly at the same time of year. Males swarm over short grass. The head of the male seems to be entirely taken up with compound eyes, below which the antennae are inserted above the mouthparts. Females have smaller eyes that are widely separated. The larvae are structurally very primitive and may often be found gregariously at the roots of grasses, cereals, and in leaf mould.

Bibionidae (fever flies, March flies, St. Mark's fly; class Insecta, order Diptera, suborder Nematocera) Family of somewhat variable flies which has been subdivided by some authors into as many as five subgroups. The adults are, typically, robust flies with shorter legs and wings than those of other families of Nematocera. Their antennae have 8–16 beadlike segments and are usually shorter than the thorax. Wings are large, with prominent anterior veins. Males have holoptic eyes, and ocelli are present. The larvae live in soil, roots, or decaying vegetation. The larvae of some species are among the most primitive of all dipteran larvae, having 12 segments, a large head, well-developed mouthparts, and no pseudopods. More than 700 species have been described.

bicentric distribution The few endemics in the Scandinavian flora are mainly restricted to either one or both of two widely separated montane areas. If they occur in both areas their distribution is described as bicentric. About 25 species and subspecies of plants are involved. The bicentric pattern possibly reflects the former existence of nunataks above the late Pleistocene ice sheet.

bichir (*Polypterus*) *See* Brachiopterygii; and Polypteridae.

Bidder's organ *See* Bufonidae.

biennial Applied to a plant that lives for two years. During the first season food may be stored for use during flower and seed production in the second year.

bifid Split in two.

Bifidobacterium (family Actinomycetaceae, order Actinomycetales) Genus of Gram-positive bacteria in which the cells are pleomorphic and often Y- or V-shaped. They are anaerobic, fermenting glucose to produce acetic acid and lactic acid. They are found in the gut in a wide range of mammals, fowls, and bees; certain species are common in human infants' intestines. They are non-pathogenic.

bifurcation ratio Dimensionless number denoting the ratio between the number of streams of one order (*see* stream order) and those of the next-higher order in a drainage network. It is a useful measure of proneness to flooding: the higher the bifurcation ratio, the greater is the probability of flooding.

big-eye *See* Priacanthidae.

bighead *See* Melamphaeidae.

big-headed turtles *See* Platysternidae.

bigmouth sleeper (*Gobiomorus dormitor*) *See* Eleotridae.

Bignoniaceae Family of mainly woody climbers, in which the leaves are pinnate and opposite. The flowers are showy, borne in cymose clusters, zygomorphic, and pentamerous, with fused sepals and petals, and with the ovary superior. The fruit is usually a capsule with numerous small, winged seeds. There are 120 genera, with 650 species, most occurring in tropical central or S. America.

bigscale *See* Melamphaeidae.

big tree (*Sequoiadendron giganteum*) *See Sequoiadendron*; and Taxodiaceae.

bilberry *See Vaccinium*.

bile Secretion, produced in the liver and stored in the gall bladder, that comprises some waste products of metabolism and a surface-active agent. It is discharged via the bile duct into the small intestine, from which it is excreted; it also serves to emulsify fats during digestion and so aids their transport across the gut membrane.

bilharzia *See* schistosomiasis.

bilimbing (*Averrhoa bilimbi*) *See Averrhoa*.

bilirubin Golden-yellow bile pigment derived from the degradation of porphyrins, in particular haem compounds, by cells of the reticulo-endothelial system, notably those of the liver.

biliverdin Green bile pigment usually formed as a result of the oxidation of bilirubin in the gall bladder.

Billardiera (family Pittosporaceae, tribe Billardiereae) Genus of eight species of subshrubs with climbing stems, endemic to Australia. They have bell-shaped flowers and fleshy fruits.

Billardiera longifolia (apple berry) Tasmanian species cultivated as an ornamental for its creamy-white and purple flowers and its blue, edible berries. *See Billardiera*.

billet Piece of wood that has been cut for fuel.

billow clouds Parallel rolls of cloud with distinct clear areas between the cloud bands, often associated with the cloud variety undulatus.

binary fission Division of one cell into two similar or identical cells: a common method of asexual reproduction in single-celled organisms.

bindweed *See Calystegia*.

binocular vision Vision that results from the ability of an animal to view an object using both eyes simultaneously, and which probably enables the animal to judge distances. In those Mammalia and Aves that possess binocular vision, the orbits are directed forward. In some arboreal Serpentes, in which the orbits are directed laterally, binocular vision may result from the possession of eyes whose pupils are long, horizontal slits located eccentrically and close to the anterior margins of the orbits.

bintangor *See Calophyllum*.

binuang *See Octomeles*.

bioassay Use of living cells or organisms to make quantitative and/or qualitative measurements of the amounts or activity of substances.

biochemical oxygen demand *See* biological oxygen demand.

biochore Little-used term from the early twentieth century ecological literature of central Europe, generally meaning a biotic district, i.e. a distinctive community and environment, and as such one of many precursors of the ecosystem concept. Also used by Raunkiaer to describe precise biological boundaries between major climatically determined plant regions and their main subdivisions, as identified by his life-form recording system (i.e. percentages of phanerotypes, chamaephytes, etc.).

biochrome *See* pigment.

biochronology Measurement of units of geological time by means of biological events. Biochronologists often derive their correlations from widespread and distinctive events in the biological history of the world based on the first and last appearances of organisms.

biocide Natural or synthetic substance toxic to living organisms. Some ecologists advocate use of this term instead of 'pesticide', since most pesticides are also toxic to species other than the target pest species. Indirectly, pesticides may also affect non-target organisms detrimentally in many other ways, e.g. by loss of food species or loss of shelter, so that the effects of pesticides may be felt throughout a whole ecosystem. The term 'biocide' indicates this property more clearly than 'pesticide'.

bioclimatology The study of climate, with particular reference to the environments of living organisms, especially to those of agricultural plants and animals, and humans; together with the disease vectors affecting humans and commercially important plants and animals.

biocoenosis (pl. biocoenoses) The living part of a biogeocoenosis, comprising the phytocoenosis (the primary producers), the zoocoenosis (the secondary producers or consumers), and the microbiocoenosis (the decomposer organisms). It is equivalent to the biotic component, or biome, in an ecosystem.

biocontrol *See* biological control.

bio-energetics The study of energy transformations in living organisms, in particular the formation of ATP in photosynthesis and by other mechanisms, and its subsequent use in metabolic processes.

biofacies Rock unit, or an association of rock units, characterized by the presence of a fossil assemblage that is restricted to that particular facies and that is typical of a specific environment.

biogenesis Principle that a living organism can arise only from another living organism, a principle contrasting with concepts such as that of the spontaneous generation of living from non-living matter. The term is currently more often used to refer to the formation from or by living organisms of any substance, e.g. coal, chalk, chemicals, etc.

biogenetic law Law formulated by the embryologist E. K. von Baer (1792–1876) stating that the early stages of development in animal species resemble one another, the species diverging more and more as development proceeds.

biogenic Applied to the formation of rocks, traces (fossils), or structures as a result of the activities of living organisms.

biogeochemical cycle Movement of chemical elements from organism to physical environment to organism in a more or less circular pathway. They are termed 'nutrient cycles' if the elements concerned are essential to life. The form and quantity of an element varies through the cycle, with amounts in the inorganic reservoir pools usually greater than those in the active pools. Exchange between the system components is achieved by physical processes (e.g. weathering) and/or biological processes (e.g. protein synthesis and decomposition). The latter form the vital negative-feedback mechanisms that regulate the cycles. Cycles may be described as varying from perfect to imperfect. A perfect cycle (e.g. the nitrogen cycle) has a readily accessible abiotic, usually gaseous, reservoir and many negative-feedback controls. By contrast, the phosphorus cycle, which has a sedimentary reservoir accessed only by slow-moving physical processes, has few biological feedback mechanisms. Human activities can disrupt these cycles, leading to pollution. Theoretically, perfect cycles are more resilient than imperfect cycles.

biogeochemical exploration *See* geobotanical exploration.

biogeocoenosis Term equivalent to 'ecosystem', often used in Soviet and Central European literature, and attributed to Sukachaev (1947). A biogeocoenosis comprises a biocoenosis (the biome, or living community), together with its habitat, which usually is termed an ecotope.

biogeographical barrier The various disjunctive geographical groupings of plants and animals are

usually delimited by one or more barriers to migration, which prevent faunal and/or floral mixing. Such barriers may be climatic, involving temperature and the availability of water, or physical, involving for example mountain ranges or expanses of sea-water.

biogeographical province Biological subdivision of the Earth's surface, usually on the basis of taxonomic rather than ecological criteria, and embracing both faunal and floral characteristics. The hierarchical status of such a unit, and the total number of such units, varies from one authority to another.

biogeographical region Biological subdivision of the Earth's surface, delineated on the same general principles as a biogeographical province, but having superior taxonomic status. The provinces are grouped into regions, of which the following are generally recognized: Antarctic, Australasian, Ethiopian, Nearctic, Neotropical, Oceanian, Oriental, and Palaearctic.

biogeography A diverse subject, traditionally focusing on the distribution of plants and animals at different taxonomic levels, past and present. Modern biogeography, however, also lays great stress on the ecological character of the world vegetation types, and on the evolving relationship between humans and their environment.

biological clock Innate mechanism of living organisms that enables them to determine and to respond to daily, lunar, seasonal and other periodicities. *See also* circadian rhythm.

biological concentration (biological magnification) Build-up through the food-chain of certain substances, natural or synthetic, in the bodies of living organisms. This is of particular importance to predators at the top of the chain, including humans, which may receive toxic doses. Substances concentrated in this way include heavy metals (e.g. lead) and organochlorine pesticides (e.g. DDT). The mechanism may cause especially serious problems where food-chains are long, as in aquatic ecosystems.

biological conservation Active management to ensure the survival of the maximum diversity of species, and the maintenance of genetic variety within species. The term also implies the maintenance of biosphere functions, e.g. biogeochemical cycling, without which the basic resources for life would be lost. Biological conservation embraces the concept of long-term sustained resource use or sustained yield from the biosphere, which may conflict with species conservation in some circumstances. Conservation of species and biological processes is unlikely to succeed without simultaneous conservation of abiotic resources.

biological control In general, control of the numbers of one organism as a result of natural predation by another or others. Specifically, the human use of natural predators for the control of pests, weeds, etc.

biological magnification *See* biological concentration.

biological oxygen demand (BOD, biochemical oxygen demand) Indicator of the polluting capacity of an effluent where pollution is caused by the take-up of dissolved oxygen by micro-organisms that decompose the organic material present in the effluent. It is measured as the mass (mg) of oxygen used by one litre of sample effluent stored in darkness at 20 °C for five days.

biological productivity Productivity of organisms and ecosystems, as defined by primary, secondary, and community productivities. *See also* primary productivity.

bioluminescence Production by living organisms of light without heat. Bioluminescence is a property of many types of organism, e.g. the fruit bodies of certain fungi, certain (mostly marine) bacteria, and dinoflagellates, fireflies, etc.

biomass (standing crop) The total weight of the living components (producers, consumers, and decomposers) in an ecosystem at any moment, usually expressed as dry weight per unit area.

biome Biological subdivision of the Earth's surface that reflects the ecological and physiognomic character of the vegetation. Biomes are the largest geographical biotic communities that it is convenient to recognize. They broadly correspond with climatic regions, although other environmental controls are sometimes important. They are equivalent to the concept of major plant formations in plant ecology, but are defined in terms of all living organisms and of their interactions with the environment (and not only with the dominant vegetation type). Typically, distinctive biomes are recognized for all the major climatic regions of the world, emphasizing the adaptation of living organisms to their environment, e.g. tropical-rainforest biome, desert biome, tundra biome.

biometrics *See* biometry.

biometry (biometrics) Quantitative biology, i.e. the application of mathematical and statistical concepts to the analysis of biological phenomena.

bionomic strategy Characteristic features of an organism or population, e.g. size, longevity, fecundity, range, and migratory habit, that give maximum fitness for the organism in its environment.

biophage *See* consumer organism.

biospecies Group of interbreeding individuals that is isolated reproductively from all other groups.

biosphere The part of the Earth's environment in which living organisms are found, and with which they interact to produce a steady-state system, effectively a whole-planet ecosystem. Sometimes it is termed 'ecosphere' to emphasize the interconnection of the biotic and abiotic components.

biosphere reserve One of a series of conservation sites designated by UNESCO in an attempt to establish an international network of protected areas encompassing examples of all the Earth's major vegetation and physiographic types.

biostratigraphy Branch of stratigraphy that involves the use of fossil plants and animals in the

dating and correlation of the stratigraphic sequences of rock in which they are discovered. A zone is the fundamental division recognized by biostratigraphers.

biosynthesis Formation of compounds by living organisms.

biota Plants and animals occupying a place together, e.g. marine biota, terrestrial biota.

biotechnology Exploitation of micro-organisms for industrial and other human purposes; the term usually refers particularly to techniques involving genetic manipulation in micro-organisms.

biotelemetry Remote-sensing method for monitoring animal movements using small transmitters attached externally to the body of the animal or implanted within the body cavity. It enables the precise locations of animals to be followed, and may also monitor changes in heart beat, e.g. in response to stress. It is especially useful for studying migratory animals in remote areas (e.g. elk, reindeer, and polar bear), and is an important aid to the study of bird migrations. *See also* radar tracking; and radio tracking.

biotic Applied to the living components of the biosphere or of an ecosystem, as distinct from the non-living, abiotic, physical, and chemical components.

biotic association Community of plants and animals. *See also* community; and plant association.

biotic climax *See* plagioclimax.

biotic factor Influence upon the environments of organisms due to the presence and activities of other organisms (e.g. the casting of shade, and competition), as distinct from a physical, abiotic environmental factor.

biotic index Scheme for grading river quality according to the diversity and abundance of the river fauna present, with particular reference to 'key species' with known pollution tolerances. The scale ranges from 10 (clean water with diverse fauna) to 0 (grossly polluted water with no fauna or with only a few anaerobic organisms).

biotic potential (intrinsic rate of natural increase) Maximum reproductive potential of an organism. It is symbolized by the letter *r*. The difference between this and the rate of increase that actually occurs under field or laboratory conditions reflects the environmental resistance. *See also* logistic equation.

biotin Member of the vitamin-B complex that serves as a prosthetic group in enzymes involved in carboxylation–decarboxylation reactions.

biotite Very widespread mineral, specific gravity 2.7–3.3, hardness 2.0–3.0, chemical composition $K(Mg,Fe)_3Al_2Si_3O_8(O,H,F)_2$. It is found in granites, syenites, and diorites; in schists and gneisses; in contact metamorphic rocks; and often in sedimentary rocks. Its colour is black, dark brown, or greenish-black, with a vitreous to sub-metallic lustre. It crystallizes in the monoclinic system. The crystals are tabular and pseudo-hexagonal; there are also lamellar aggregates, and flakes. It shows a very well marked, perfect, basal cleavage. It is a rock-forming mineral.

biotope Environmental region characterized by certain conditions and populated by a characteristic biota or community.

biotopographic unit Small habitat unit with distinctive topography formed by the activities of an organism, e.g. an ant hill, or a tussock. The term may also refer to small topographic units that, by their aspect, position, or other characteristics, generate distinctive micro-environments for living organisms. Examples include solar or shade slopes, windward slopes, and similar units in sand-dunes.

biotroph Parasitic organism that obtains its nutrients from the living tissues of its host organism.

biotype 1 Naturally-occurring group of individuals with identical genomes. 2 Physiological race, i.e. a group of individuals identical in structure but showing differences in physiological, biochemical, or pathogenic characters.

biozone Total range of a given species defined within specific time limits.

Bipes (two-legged worm lizards; order Squamata, suborder Sauria (Lacertilia), family Amphisbaenidae) Genus of Mexican worm lizards with well-developed forelimbs which are used to scratch a cavity prior to tunnelling. The wedge-shaped head compacts the soil as the lizard burrows. *Bipes* grow to a length of about 20 cm.

bipinnaria larva In Asteroidea, a larva derived from the auricularia but differing from it in the development of the ciliated bands.

bipinnate Of leaves, twice pinnate.

bipolar distribution of fish The distribution of certain families, genera, and species of fish (e.g. the families Petromyzonidae and Cottidae) is limited to the cooler waters of the northern and southern hemispheres, no immediate relatives being found in the more tropical regions of the world. The deep-sea anglerfish, *Ceratias holboelli*, is thought to occur only in the cold waters of the Arctic and Antarctic.

biramous Two-branched.

birch *See Betula*.

bird-of-paradise flower *See Strelitzia*.

birds *See* Aves.

bird's-nest fungi Common name for those fungi of the Nidulariales that form cup-shaped or funnel-shaped fruit bodies within which occur the peridioles, resembling eggs within a miniature bird's-nest.

birds of paradise *See* Paradisaeidae.

birdwing butterflies *See* Papilionidae.

birefringence (double refraction) The splitting of a ray of ordinary light into two rays, as it passes through an anisotropic crystal. The two rays are polarized in mutually perpendicular planes. Under a petrological (polarizing) microscope, the crystal

will exhibit bright polarizing colours which are of considerable importance in the identification of minerals.

birthwort *See* Aristochiaceae.

Bischofia (family Staphyleaceae) Monotypic genus (*B. javanica*) of trees formerly placed incorrectly in the Euphorbiaceae. They have stipulate, spiral, pinnate leaves composed of 3–5-serrate leaflets. They are dioecious, the flowers being apetalous, and having five sepals, five stamens, and a trilocular ovary, with two pendulous ovules. The fruits are leathery or fleshy, and indehiscent. The trees yield useful timber. They are native in USSR (Georgian Colchic forest), E. to C. China, Malesia, and the Pacific islands.

bise Local term for a northerly winter wind affecting mountainous regions of S. France, e.g. Languedoc, where the 'bise noire' is associated with heavy cloud.

bisexual Applied either to a species comprising individuals of both sexes, or to a hermaphrodite organism (in which an individual animal possesses both ovaries and testes, and an individual plant possesses both stamens and pistils in the flower).

bishops *See Euplectes*.

Bison *See* Bovidae.

Biston betularia (peppered moth; order Lepidoptera) Moth which has been the subject of classical studies of industrial melanism, where there is selective predation by birds upon light moths that are conspicuous against a dark, sooty background, and, conversely, upon dark moths against a light, soot-free background. *See also carbonaria*.

bitheca One of the three types of graptolite thecae, possibly containing the male zooid. *Compare* autotheca; and stolotheca.

biting lice *See* Mallophaga.

biting midges *See* Ceratopogonidae.

bitis *See Palaquium*.

Bitis arietans (puff adder; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Highly venomous snake, dangerous to humans, which is common throughout Africa south of the Sahara. It grows up to 1.5 m long. When provoked it inflates the body and hisses, while preparing to strike. It feeds on small vertebrates.

Bitis nasicornis (rhinoceros viper, river-jack; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Species of brightly-coloured viper, up to 120 cm long, with a pair of large prominent scales above each nostril. It occurs in C. African forests, usually close to water.

bittern *See* Ardeidae; and *Botaurus*.

bitunicate Applied to an ascus in which the outer and inner layers of the ascus wall separate during ascospore release.

Biuret reaction Colorimetric reaction that serves as a basis for the qualitative and quantitative determination of proteins. It depends upon the fact that in a strongly alkaline solution, compounds such as tripeptides and proteins, which have two amide or peptide bonds linked directly or through intermediate carbon atoms, react with copper sulphate to give a violet colour. Dipeptides and most amino acids do not give this reaction.

bivalent In genetics, applied to two homologous chromosomes when they are paired during the prophase of meiosis.

Bivalvia *See* Pelecypoda.

bivouac *See* Dorylinae.

Bixa Sole genus of the family Bixaceae, comprising three or four species of tropical American shrubs. *B. orellana* (annatto) contains a vivid orange pigment in the testa, used as a food colourant.

Blaberidae (class Insecta, order Blattodea) Family of medium to large, broad-bodied cockroaches, most of which have short, stout legs, and relatively short antennae. Some species burrow in the ground, or live in rotting wood. *Leucophaea maderae* (Madeira cockroach) is able to stridulate, and produces an offensive odour when disturbed. *Gromphadorhina* species can produce sound by forcing air through the spiracles. This mainly tropical group includes the largest cockroaches known.

black-backed snake blenny (*Ophiclinus gracilis*) *See* Ophiclinidae.

black bean (*Castanospermum australe*) *See Castanospermum*.

black beetle (*Blaps mucronata*) *See* Tenebrionidae.

blackberry *See Rubus*.

blackbirds 1 (*Turdus merula*) *See Turdus*. 2 (New World blackbirds) *See* Icteridae.

black-boy (*Xanthorrhoea hastilis*) *See Xanthorrhoea*.

black coral *See* Antipatharia.

black currant (*Ribes nigrum*) *See Ribes*; and Grossulariaceae.

black death Popular name given to the epidemic of bubonic plague that caused millions of deaths in the fourteenth century.

black dragonfish 1 *See* Idiacanthidae. 2 *See* Melanostomiatidae.

black-faced blenny *See* Trypterygiidae.

blackfish (black ruffe, *Centrolophus niger*) *See* Centrolophidae.

black flies *See* Simuliidae.

blackfly *See* Aphididae.

black grass (*Alopecurus myosuroides*) *See* herbicide.

black grouse (*Lyrurus*) *See Tetrao*.

blackhead Of turkeys: a disease caused by the protozoon *Histomonas meleagridis*. The disease affects the caecum and liver of the bird, and the mortality rate may be high. The disease is transmitted by a nematode worm parasitic in the intestines of turkeys.

black ice Type of glazed frost (e.g. on roads or the superstructures of ships), caused when water falls on a surface that is below freezing temperature. The thin sheet of ice is rather dark in appearance and, unlike white hoar frost or rime, may be hard to see. *See also* glaze.

black jack *See* sphalerite.

black kingfish *See* Rachycentridae.

blackleg Name given to a number of plant diseases in which symptoms include blackening of the base of the stem, often followed by the collapse of the stem. The diseases may be caused by any of several fungi or, less commonly, bacteria.

black mildew Plant disease caused by a fungus belonging to the family Perisporiaceae. The name may also refer to the fungus itself.

black mustard *See Brassica*.

black ruffe (blackfish, *Centrolophus niger*) *See* Centrolophidae.

black salamander *See Salamandra atra*.

black sassafras *See Atherosperma moschatum*.

black scours Type of dysentery in calves, caused by bacteria of the genus *Campylobacter*.

black smelts *See* Bathylagidae.

black-stem rust Disease which affects a wide range of cereals and other grasses. Symptoms include the appearance on stems and leaves of patches of reddish-brown spores. The causal agent is a fungus, *Puccinia graminis*; this organism requires two hosts to complete its life cycle, the other host being the barberry (*Berberis*).

black swan (*Cygnus atratus*) *See Cygnus*.

blackthorn *See Bursaria spinosa*.

black walnut (*Juglans nigra*) *See Juglans*.

black wattle (*Callicoma serratifolia*) *See Callicoma*.

black widow spider *See Latrodectus mactans*.

bladder Bag, formed from animal or plant tissue, in which metabolic products, or air, may be stored. In some plants, e.g. *Fucus* (wracks), air held in bladders causes parts of the plant to float. In others, e.g. *Utricularia* (bladderwort), bladders borne on the leaves are traps that can be expanded rapidly in response to the stimulation of a trigger hair, drawing in small aquatic animals which are then digested.

bladderwort *See* Lentibulariaceae.

bladder wrack Common name for the brown seaweed *Fucus vesiculosus*. The thallus is variable; it is typically flattened and strap-like, repeatedly forked, and has prominent midribs and (usually) paired air-bladders which give buoyancy to the plant. Bladder wrack grows, often abundantly, on rocks, breakwaters, etc., between the high- and low-water marks. ('Bladder wrack' is sometimes used as a synonym for 'egg wrack'.)

Blandfordia (family Liliaceae) Genus of five species of plants with stiff, fine leaves, and red to yellow flowers supported on a stiff stalk. The genus is endemic to Australia and often found in the wetter regions of the south, often under *Eucalyptus*.

blanket bog Ombrogenous bog community, typical of flat or moderately sloping areas in very wet, oceanic climates with high humidity. In the British Isles blanket bogs are widespread on the Pennine summits, in NW Scotland, and in parts of Ireland. *See also* ombrogenous peat; *Compare* raised bog; and valley bog.

blanket weed *See* Cladophorales.

Blaps mucronata (black beetle) *See* Tenebrionidae.

blast disease Common disease of rice, caused by the fungus *Pyricularia oryzae*. Lesions develop on the leaf-sheaths and on the stems, and the weakened stems are easily broken.

Blastocladiaceae (order Blastocladiales) Family of fungi in which the thallus varies in complexity according to species. It may be polycentric, or monocentric. Species are found in soil, mud, etc.

Blastocladiales (class Chytridiomycetes) Order of fungi in which the thallus is usually mycelial, and may be monocentric or polycentric. The order contains three families. The species are chiefly saprotrophic, occurring in soil, fresh water, etc.

blastocoel (segmentation cavity) Cavity that appears during embryonic development in animals at the end of cleavage of the egg. It is found within the mass of cells that makes up the blastula, and is filled with fluid.

blastocyst Mammalian embryo at the stage at which, after cleavage, it is implanted in the wall of the uterus. It consists of a thin-walled, hollow sphere (trophoblast) enclosing a blastocoel: attached to the inner surface of the trophoblast at one end there is a sheet of cells designed to become the embryo proper.

blastodisc (germinal disc) Disc-shaped layer of cytoplasm formed at the animal pole by the cleavage of a large, yolky egg, e.g. that of a bird or reptile. Mitosis within the blastodisc gives rise to the embryo and its membranes.

Blastoidea (subphylum Pelmatozoa) Class of sessile, bud-like echinoderms, with biserial brachioles, well-developed, pentameral symmetry; theca composed of 17 major plates arranged in three circlets; and hydrospires (infolded, thin-walled, calcareous, linear structures) developed on each side of the ambulacra. Blastoidea range in age from Silurian to Lower Permian. They are uncommon as fossils, except in shallow-water calcareous rocks, often associated with 'reef' limestones.

blastomere One of the cells formed by the division of the fertilized egg during cleavage and prior to gastrulation. The blastomeres may differ in size, the larger ones being termed macromeres and the smaller ones micromeres.

Blastomycetes (subdivision Deuteromycotina) A class of fungi that characteristically form single yeast-like cells that reproduce by budding, i.e. a new cell is formed by extrusion from the periphery of the parent cell. In some cases a poorly-developed mycelium may be formed. There are two families.

blastomycosis Disease in which lesions develop on the skin, and in the lungs and bones. The causal agent is the fungus *Blastomyces dermatitidis*. The disease occurs in parts of N. America and Africa.

blastopore Mouth-like opening of the archenteron or gastrocoel on the surface of an embryo in the gastrula stage. In many animals the blastopore becomes the anus, although in some it closes up at the end of gastrulation and may appear again at or near the same site. The blastopore is formed by an inward movement of the endoderm and mesoderm cells of the archenteron during gastrulation. Sometimes this movement is incomplete, so that an open pore does not develop; this explains the primitive streak of a bird or mammal embryo during gastrulation. In that case it is referred to as a 'virtual' blastopore.

blastospore Fungal spore that is formed by budding.

Blastozoa (phylum Echinodermata) Subphylum, whose validity is not universally accepted, that includes the classes Eocrinoidea, Rhombifera, Blastoidea, and Parablastoidea.

blastozooid Member of a colony of animals which are produced by asexual budding.

blastula Early embryonic stage of an animal around the time of cleavage. Usually it consists of a hollow sphere of cells. It is formed immediately prior to gastrulation, the movements by which cells begin to migrate to the positions in which they will develop into organs.

Blatta orientalis (oriental cockroach; order Blattodea, family Blattidae) Dark brown, short-winged cockroach, about 2 cm long as an adult, which is one of the most important domestic roach pests, doing as much damage as *Periplaneta americana* (American cockroach) and *Blattella germanica* (German cockroach).

Blattella germanica (German cockroach; order Blattodea, family Blattellidae) One of the most common roach pests. *B. germanica* is light brown, with two longitudinal stripes on the pronotum. It is about 2 cm long as an adult.

Blattellidae (class Insecta, order Blattodea) Large, cosmopolitan family of generally small cockroaches, which have long antennae and slender legs. Many species are fully winged in both sexes, and some species, most notably *Blatella germanica* (German cockroach), are domestic pests.

Blattidae (class Insecta, order Blattodea) Cosmopolitan family of medium to large cockroaches which includes such domestic pests as *Periplaneta americana* (American cockroach), and *Blatta orientalis* (oriental cockroach).

Blattodea (cockroaches, roaches; class Insecta) Order of medium to large, exopterygote insects in which the forewings are modified as rather strongly sclerotized tegmina. Wings are absent in some groups. The legs are gressorial (modified for running), and the body is dorsoventrally compressed. Auditory organs are absent. Females have a small, concealed ovipositor, and eggs are laid in an ootheca. Most cockroaches are nocturnal, and during the day are usually found hiding in crevices. Burrowing and cave-dwelling species are known, and some species are even amphibious. Cockroaches may be adapted to desert conditions, or live in tropical rain forest. It is thought that most cockroaches are omnivorous. Of the approximately 3500 species known, some are of economic importance as domestic pests. *See also Periplaneta americana*; *Blatta orientalis*; and *Blatella germanica*.

Blechnaceae Family of terrestrial ferns with scaly rhizomes, to which the fronds are not jointed. The sori are short, or joined together in a continuous line, on a vein parallel to the midrib of the pinna. The indusium is outside the sorus, attached to the leaf surface or margin. Spore-bearing fronds are often distinct from the vegetable ones. There are 11 genera, of cosmopolitan distribution, containing more than 200 species, of which 180 are in the genus *Blechmum*.

bleeding In plants, exudation of the contents of the xylem stream at a cut surface due to root pressure.

Bleeker's devilfish (*Paraplesiops bleekeri*) *See* Plesiopidae.

bleicherde Ashy-grey soil that forms the leached layer in a podzol soil.

blending inheritance Inheritance in which the characters of the parent appear to blend to form an intermediate state in the offspring, and in which there is no apparent segregation in later generations. The concept was proposed originally by biologists in the nineteenth century, including Darwin, but later it was discredited as a model of inheritance after the results of Mendel's experiments had been recognized.

Blenniidae (blennies; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of small, mostly marine fish found in shallow waters, even in tidal pools, in large numbers. They are identifiable by their long dorsal and anal fins, virtually naked skin, and two pronounced rays in each of the pelvic fins located below the gills; often they have tufts of skin (tentacles) above the head. Many species rely on skin coloration for protection. There are about 550 species, distributed worldwide in tropical and temperate waters.

Blennodia (family Cruciferae) Genus of 12–14 species of annual plants endemic to Australia. They form part of the flora of *Eucalyptus–Acacia* woodland found on sands, and flower following the winter rains.

blepharoplast Cylindrical body composed of parallel peripheral rods connected to the axial filaments of flagella or cilia.

blewit Common name for the fruit body of *Lepista* species, e.g. wood blewit is *L. nuda* (*Tricholoma nudum*), field blewit is *L. saeva* (*Tricholoma saevum*). Both species are edible.

blight Non-specific term applied to any of a wide range of plant diseases. The causal agent is usually a fungus. *See* (for example) potato blight.

blind cavefish (*Anoptichthys jordani*) *See* Characidae.

blind snakes *See* Typhlopidae.

blind valley Water-eroded valley that is abruptly terminated downstream by a closing in of its side walls. It is typical of limestone terrains in which a stream that has flowed for some distance at the surface and has cut a valley descends suddenly through a swallow-hole or doline.

blind worm *See Anguis fragilis*.

blister beetle *See* Meloidae.

blizzard Storm of blowing snow with high winds and low temperatures. Blizzards are a notable climatic feature of the northern and central parts of the USA in winter, and are related to depression tracks.

bloat Condition of ruminant animals in which gases accumulate in the rumen, causing it to inflate. If not relieved, bloat may lead to death due to pressure on the heart and lungs.

blockfield (felsenmeer) Spread of coarse, angular, frost-shattered rock debris resting on a level or gently sloping upland surface, and found in present or former periglacial environments. Its thickness reflects the effective depth of gelifraction. *See also* frost wedging.

blocking In synoptic meteorology, the establishment in the mid-latitudes of a high-pressure system that interrupts or diverts for a considerable period the typically eastward movement of depressions and other synoptic features in the zonal flow. Over W. Europe, for example, depressions are forced by blocking to move northward toward Scandinavia or southward over S. France and Spain.

blocking anticyclone *See* blocking high.

blocking high (blocking anticyclone) In synoptic meteorology, an anticyclone with deep circulation so placed as to interrupt or divert the eastward movement of the typical succession of low-pressure features (depressions) in the zonal flow of mid-latitudes. The usual zonal flow of middle latitudes is at such times diverted into more meridional flow around the high-pressure area, where settled weather can then result. *See also* air mass.

blood In animals, a fluid circulated through the body by muscular activity and usually containing respiratory pigments conveying oxygen, food materials, excretory products, cells that produce antibodies (lymphocytes), and cells that invade tissue to attack invading organisms.

blood clotting Response to the injury of a blood vessel in which the escape of liquid blood is prevented by its conversion into a solid mass, or clot, composed of fibres of fibrin in which blood cells are enmeshed. In vertebrates, a soluble protein, fibrinogen, found in the blood plasma is acted upon by the enzyme thrombin. As a result, a negatively charged peptide is split off the fibrinogen molecule, leaving monomeric fibrin; this is capable of rapid polymerization to produce the tangle of insoluble threads that forms a clot. Active thrombin is formed from inactive prothrombin, also found in blood plasma, by a very complex process involving a lipoprotein factor liberated by rupturing blood platelets, a protein plasma thromboplastin component (PTC), antihaemophilic globulin (AHG), calcium ions, etc. Removal of free calcium from the blood, e.g. by adding citrate or oxalate, inhibits the formation of thrombin.

blood group Group of individuals (usually humans, but the term may also refer to other primates) classified according to the occurrence of agglutination of the red blood cells when bloods from incompatible groups are mixed. Agglutination occurs when blood from any two groups is mixed: a reaction occurs between agglutinogens (antigens) in red blood cells and agglutins (antibodies) in plasma. The classical blood groupings and their frequencies in the human population are: A (41%), B (9%), AB (3%), and O (47%), although very many other groups have been identified more recently, e.g. Duffy, Kidd, Lewis, Lutheran, MN, P, and Rh.

blood plasma The almost colourless fluid remaining when all corpuscles have been removed from blood (present as a suspension after centrifugation of whole blood). It contains the protein fibrinogen, which is acted upon by the enzyme thrombin to cause clotting; and antibodies responsible for immune reactions on combining with antigens.

blood rain Phenomenon of reddish coloured rainfall, caused by dust particles that have been lifted up from arid areas and carried long distances by the winds before they are washed out in precipitation. Saharan red dust sometimes occurs in rainfall over Europe, even as far north as Finland.

bloodsucker *See Calotes versicolor*.

blow flies *See* Calliphoridae; and *Calliphora vomitoria*.

blowout Wind-eroded section of a sand dune that has been largely stabilized by vegetation. Erosion results from a break in the vegetation cover, due typically to overgrazing, or to recreational pressure. A parabolic dune may result.

blue aeshna *See Aeshna cyanea*.

bluebell 1 (Australian) *See Wahlenbergia*. 2 (European, *Endymion* species) See Liliaceae.

bluebottles *See* Calliphoridae; and *Calliphora vomitoria*.

blue butterflies *See* Lycaenidae.

blue cod (*Parapercis colias*) *See* Mugiloididae.

blue-finned ghostfish (*Solenichthys cyanopterus*) *See* Solenostomidae.

bluefish (*Pomatomus saltator*) *See* Pomatomidae.

bluegill (*Lepomis macrochirus*) *See* Centrarchidae.

blue-green algae *See* Cyanobacteria.

bluegum (*Eucalyptus regrans*) *See Eucalyptus*.

blue john *See* fluorite.

blue marlin (*Makaira nigricans*) *See* Istiophoridae.

blue Moon (blue Sun) Occasional appearance of the Moon or Sun when partly obscured by large particles in the atmosphere, as in dust storms, or following forest fires or great volcanic explosions. More commonly the Moon or Sun viewed through dust or smoke trails appears very white, but when the suspended particles are predominantly of one size the luminary sometimes appears blue, at other times green or orange. The phenomenon is attributed to diffraction, although no full explanation seems to be known. The smaller the particles, the more the colour of the Sun or Moon tends to the blue end of the spectrum. The phenomenon is believed to be more common in China than elsewhere. (In the neighbourhood of one great historic volcanic explosion the Sun was seen as an azure blue sphere.)

blue mould 1 Common name for the visible mat of mycelium-bearing, bluish conidia formed by species of *Penicillium*, e.g. on fruit. 2 Disease of tobacco caused by *Peronospora tabacina*.

blue parrotfish (*Scarus coeruleus*) *See* Scaridae.

blue pincushion (*Brunonia australis*) *See Brunonia*.

blue rock whiting (*Haletta semifasciata*) *See* Odacidae.

blues (blue butterflies) *See* Lycaenidae.

blue sapphire *See* corundum.

blueschist Metamorphic rock that has undergone regional metamorphism at low temperatures and high pressures. Blueschists contain abundant blue glaucophane, which is a blue amphibole derived from the metamorphism of geosynclinal deposits. Blueschists are usually associated with destructive plate-margin environments.

blue shark (*Prionace glauca*) *See* Carcharhinidae; and nictitating membrane.

blue-stain Common type of staining of freshly-cut timber, caused by the growth of fungi (particularly species of *Ceratocystis*) in the sapwood.

blue sun *See* blue moon.

bluethroats *See Luscinia*.

bluetongue Serious disease of sheep and other ruminants. Symptoms include fever, oedema, and lameness. Mortality rates may be high. The causal agent is a virus belonging to the orbvirus group. The disease is prevalent chiefly in Africa.

blue whale (Sibbal's rorqual, *Balaenoptera musculus*) *See* Balaenopteridae.

blusher Common name for the fruit body of *Amanita rubescens*. It is mushroom-shaped, with reddish-brown or brown cap bearing scattered whitish patches (remnants of the universal veil). The flesh turns pink or reddish on breaking or bruising. The stem is white. It is common on ground in woodland during late summer and autumn.

Boa constrictor (boa constrictor; order Squamata, suborder Serpentes (Ophidia), family Boidae) Species of snake whose habitat varies from semi-desert to dense jungle. It grows to about 4.5 m long and feeds on large lizards, birds, and mammals. It seldom enters water. It is found from Mexico to Argentina, and on some W. Indian islands.

boarfish *See* Caproidae; and Pentacerotidae.

boas *See* Boidae.

boat-billed heron (*Cochlearius cochlearius*) *See* Ardeidae; and Cochleariidae.

bobcat (bay lynx, *Lynx rufus*) *See Lynx*.

BOD *See* biological oxygen demand.

bodh-tree (pipal-tree, *Ficus religiosa*) *See* banyan; and *Ficus*.

body louse (*Pediculus humanus*) *See* Pediculidae.

Boehmeria (family Urticaceae) Genus of trees and shrubs including *B. nivea* (China grass or rhea), which is cultivated in China for the long, tough, silky fibre of the inner bark, and in the tropics—as the variety *tenacissima*—for ramie fibre. There are 100 species, occurring in the tropics and northern subtropics.

boehmite Mineral, specific gravity 3.0, hardness 4.0, chemical composition AlO(OH), named after the nineteenth century German chemist J. B. Böhm. It occurs extensively in the weathering profiles of rocks together with gibbsite, diaspore, and kaolinite, and is an important constituent mineral of bauxite. It is normally white. It crystallizes in the orthorhombic system. It normally occurs as microscopic grains, or as pisalitic aggregates. It is used for aluminium production.

bog Plant community of acidic, wet areas. Decomposition rates in it are slow, favouring peat development. Typical plants include bog-mosses (*Sphagnum* species), 'sedges' (e.g. *Eriophorum* species), and 'heathers' (e.g. *Calluna vulgaris* and *Erica tetralix*). Insectivorous plants (e.g. sundews, *Drosera* species) are especially characteristic. They compensate for low nutrient levels by trapping and digesting insects. Three types of bog community are commonly distinguished: ombrogenous blanket, raised bogs, and valley bogs. These reflect the different physiographic and climatic conditions that may give rise to bog formation. *Compare* fen.

bogbean *See* Menyanthaceae.

bog peat *See* peat.

Bohr effect Decrease in the affinity of haemoglobin for oxygen, brought about either by a decrease in pH or by an increase in the partial pressure of carbon dioxide. It is an important mechanism in the release of oxygen by haemoglobin in the blood in respiratory tissues, where the partial pressures of carbon dioxide are high.

Boidae (constricting snakes; order Squamata, suborder Serpentes (Ophidia)) Family of large, tropical snakes that kill their prey by constriction. They have a flexible skull, paired lungs, and enlarged ventral scales; the pelvis and rudimentary hind limbs are present as anal spurs. The family includes the pythons (all Old World in distribution) and the boas (mainly New World in distribution). There are about 70 species. *See also Boa constrictor*, *Eunectes murinus*; and *Python reticulatus*.

bole The trunk of a tree.

Boletaceae (order Agaricales) Family of fungi which form mushroom-shaped fruit bodies that typically bear a layer of tubes on the underside of the cap (in place of the gills of a mushroom). The hymenium lines the inner surface of the tubes. There are many genera, including both edible and poisonous species. They are found on the ground under trees, with which they commonly form mycorrhizal associations.

bolete Fungus of the family Boletaceae. *See also* cep.

bolide Large meteor that explodes in passing through the Earth's atmosphere.

bolling The permanent trunk of a pollarded tree.

Bølling interstadial Relatively warm period that occurred towards the end of the last (Weichselian) glaciation in NW Europe, and which is named after the type site in Denmark. The event took place about 13 000–12 000 radio-carbon years BP.

bolson Intermontane basin extending from the divide of one block-faulted mountain to the divide of the adjacent mountain. The surface form is made up of mountain front, bajada, pediment, and playa. It is classically described for the basin-and-range province of the western USA.

bomb (geol.) *See* volcanic bomb.

Bombacaceae Family of trees, closely related to Malvaceae, in which the trunk is often stout, and the leaves often palmately compound and usually scaly. The flowers are often large, and hermaphrodite; with five sepals and petals, usually partly united; numerous free stamens; and a superior ovary of 2–5 fused carpels. The fruit is a big, woody capsule, often spiny, or tessellated. There are 20 genera, with 180 species, distributed in the tropics.

bombardier beetle (*Brachinus* species) *See* Carabidae.

Bombax (family Bombaceae) Genus of deciduous trees with thorny trunks and twigs. The inner fruit wall and seeds are covered with down. *B. malebaricum* of India and Sri Lanka produces samul or silk-cotton used in upholstery. There are eight species, occurring in the Old World tropics.

Bombay duck *See* Harpadontidae.

Bombina bombina (fire-bellied toad; order Anura (Salientia), family Discoglossidae) Species of primitive, essentially aquatic toads, which are grey-black, with a red, speckled belly. They grow to 4 cm long. The male has internal vocal sacs which inflate the throat. Nuptial pads develop on the lower arm and the first two fingers. The species occurs in C. and E. Europe.

bombs (geol.) *See* volcano.

Bombus (bumblebees) *See* Apidae.

Bombycidae (silk moths; order Lepidoptera) Family of moths with broad and generally brown wings. The antennae are bipectinate. The larvae spin very dense silk cocoons. There are few species, found mainly in tropical Africa and Asia.

Bombycilla (waxwings; family Bombycillidae) Genus of brown-grey birds with crests, and secondaries that have red, wax-like tips. The tail is tipped with yellow or red. They have short, stout bills, and short legs. They are arboreal, and gregarious in winter. They feed mainly on berries, and nest in pine trees. There are three species, found in Europe, N. America, and Japan.

Bombycillidae (hypocolius, silky flycatchers, waxwings; order Passeriformes) Family of variable, soft-plumaged, mostly crested birds, inhabiting forests, plains, and deserts, feeding on fruit and nesting in trees. There are five genera, with eight species, although the silky flycatchers are sometimes placed in a separate family Ptilogonatidae. They are found in N. and C. America, Europe, and Asia.

Bombyliidae (bee-flies; class Insecta, order Diptera, suborder Brachycera) Family of flies, most of which are medium to large, with densely pubescent bodies, and slender legs. The proboscis is elongate, points forward, and is adapted for feeding on nectar from flowers with long corollas. The third antennal segment is simple, with the style small or absent. Cell M_3 is absent from the wing venation. Their common name refers to their appearance and adult behaviour, and to their larvae, which are parasitic upon bees and wasps, although some species have larvae that parasitize other insects. Eggs are laid near the entrance to the nest of the specific bee host parasitized by that species of bee-fly. The tiny larvae enter the nest and usually wait until the bee larva has pupated before metamorphosing from a small, mobile animal to a smooth, fat larva which feeds on the bee pupa. The bee-fly pupa is dual-phased. The first pupa is 'normal'; the second stage has a sharp battering ram with which to break down the nest cell wall, which is made by the adult bee when closing the cell. The adult bee-fly emerges once the second-stage pupa has ruptured the seal. More than 2000 species of bee-flies have been described. *See also* venation.

Bombyx mori (common silk moth; order Lepidoptera, family Bombycidae) Moth used for the commercial production of silk; the species is no longer found wild. A silk cocoon is spun by the larva. After softening, the cocoon is unwound mechanically. A single cocoon may yield up to 3 km of silk. Commercial production may have started before 4700 BC in China. The larvae feed on mulberry leaves.

bone Skeletal tissue of vertebrates, consisting of cells arranged regularly in a matrix mainly of collagen fibres, together with a salt of calcium and phosphate (bone salt) which accounts for more than half the total weight. The cells are connected by channels permeating the matrix and carrying blood vessels and nerves. Certain large bones contain marrow, in which white blood cells are produced.

bonefish *See* Albulidae.

bonnetfish *See* Emmelichthyidae.

Bonnetiaceae Family of shrubs and small trees closely related to Theaceae. The leaves are simple,

without stipules. The flowers are pentamerous, with many stamens, and a superior ovary of three or five fused carpels. The fruit is a capsule. There are three genera, with 22 species, occurring in the tropics of Asia and America.

bonte-quagga (*Equus burchelli*) *See Equus*; and zebra.

bony fish (Osteichthyes, Teleostomi) Fish in which the endoskeleton is at least partly ossified, including the dermal bones of the upper and lower jaws. Characteristic features are the terminal mouth, homocercal tail, operculum covering the gills, scales on the skin, and the presence of a swim-bladder (although sometimes this has been lost in the course of later evolution).

bony tongue *See* Osteoglossidae.

boobies *See Sula*; and Sulidae.

book lungs One of the two kinds of respiratory organ found in spiders. They are located in the abdomen, just below the pedicel, and are composed of many fine leaves. Blood is passed over a large surface area to absorb oxygen. The openings of the book lungs (branchial opercula) are situated on the ventral surface of the abdomen and may be closed to prevent water loss. The other type of organ is a tracheal spiracle located just anterior to the spinnerets. The fastest-moving spiders have no book lungs, but have instead two pairs of tracheal spiracles; these are also commonly found in small species, for which water loss is a special consideration. Book lungs are believed to be the ancestral type of respiratory organ in arachnids.

boomslang *See Dispholidus typus*.

Boopiidae (order Phthiraptera, suborder Amblycera) Family of chewing lice which are parasitic chiefly on Australian marsupials. Only two species are not found on marsupials: *Heterodoxus spiniger* has become established on dogs, presumably having transferred to dogs since humans introduced them to Australia, and is now found all around the world between latitudes 40 °N and 40 °S; and *Therodoxus oweni* is found on the cassowary. Members of the family differ from other Amblycera in possessing a seta borne on a protuberance on each side of the mesonotum, and the fusion of the metanotum to abdominal tergum I. There are eight genera, with about 35 species.

boot-lace fungus Common name for the fungus *Armillaria mellea*, so called because of the resemblance of its black rhizomorphs to boot-laces.

bor Within the closed-forest subzone of the boreal-conifer belt in the USSR, open woodlands dominated by *Pinus sylvestris* (Scots pine) occur on dry sandplains. They are known locally as bors, and similar vegetation types are known in Canada.

bora Regional term for a cold and typically very dry wind from the north-east, blowing down from the mountains on the E. side of the Adriatic Sea. They are most common in winter on N. Adriatic coasts. The wind is probably a consequence of continental high pressure in central Europe with low pressure to the south in the Mediterranean. The wind is often accompanied by much precipitation when it is associated with depressions in the Adriatic. In other areas it is used as a generic term for cold squalls moving downhill from uplands.

Boraginaceae Family of herbs, or rarely shrubs or trees, most of which are rough or hispid, usually with rounded stems, and with alternate, exstipulate, entire leaves. The flowers are usually regular, and borne in curved cymes. The calyx is five-toothed; the corolla five-lobed, and saucer-, funnel-, or bell-shaped: it is often pink in bud, changing later to blue. There are five stamens, alternating with the corolla-lobes. The ovary is four-celled, or less often two-celled, with the style inserted between the four lobes, or terminal. The fruit is normally composed of four nutlets. There are about 85 genera, with 1600 species, which are cosmopolitan in distribution, but centred in S. Europe and E. Asia.

Borassodendron (family Palmae) Genus of stout, solitary palm trees with massive fan leaves, and a smooth, knife-edged stalk. They are dioecious, the little-branched, stout inflorescence forming among the leaves. The flowers occur in groups of 2–6, enclosed in bracts. The fruits are massive, globose, 12 cm in diameter, and in pendulous bunches, with a fibrous pericarp. There are three seeds, with thick, stony walls protruding as flanges into the endosperm. There are two species, native to rain forest in S. Thailand, Malaya, and Borneo.

Borassus (lontar, palmyra palm, tal; family Palmae) Genus of stout, solitary palm trees, with massive fan leaves which have short, spiny stalks split at the base, through which the sparsely-branched, stout inflorescence hangs. They are dioecious, the flowers sunken in groups. The fruits are big, globose, and 18 cm in diameter. The pericarp is fibrous or fleshy, and is edible when ripe. There are three seeds, with thick, stony walls. The leaves provide writing material; the flower is a source of toddy. The trees are much planted. There is one (or several polymorphic) species, native to Africa, Madagascar, Sri Lanka, India, and seasonal areas from SE Asia to Queensland.

borax Evaporite mineral, specific gravity 1.7, hardness 2.0–2.5, and with the chemical composition $Na_2B_4O_7.10H_2O$. It occurs as a sediment of saline lakes, and in association with halite, sulphates, carbonates, and other barium minerals. It is distinguished by its crystal form, low specific gravity, and solubility in water. It is white, or sometimes greyish or tinged blue, and has a white streak and a vitreous to resinous lustre. It crystallizes in the monoclinic system. It is a source mineral for boric compounds.

Bordetella Genus of bacteria not assigned to a taxonomic family. The cells are very small, ovoid, Gram-negative, and non-motile, or motile with many flagella. They are chemo-organotrophic, and can grow only in the presence of air. They are found as parasites and pathogens of the respiratory tract in mammals (*B. pertussis* is the causal agent of whooping cough).

bore Very rapid rise of the tide, in which the advancing flood waters form a wave with an abrupt front. Tidal bores occur in certain shallow estuaries and river mouths where there is a large tidal range, e.g. the Amazon, the Bay of Fundy, the Tsing Kiang in China, and the Severn, Trent, and Ouse rivers in England.

boreal climate The climate associated with the boreal ('taiga') forest zone of Eurasia, where it extends to 65–70 °N in the west and 50 °N in the east, and N. America, where it extends from the fringe of the tundra southwards to 55 °N in the east. Winters are long and cold, with temperatures below 6 °C for 6–9 months, and with short summers with temperatures averaging more than 10 °C. Precipitation, as snow in winter, typically amounts to 380–635 mm per annum.

boreal forest Circumpolar, cold-temperate forest dominated by conifers, but with some broad-leaved hardwoods. To the north it is bounded by tundra and to the south by temperate mixed forest, steppe, or semi-desert. The American and Asian sectors of the forest are floristically more diverse than the European sector.

Boreal period Period in post-glacial (i.e. post-Devensian or Flandrian) times from about 8800–7500 BP, which preceded the climatic optimum of early Atlantic times. Pollen records typically show an increasing abundance of thermophilous tree species and also indicate the drier, more continental conditions that characterized the ensuing Atlantic period. The early Boreal corresponds to late Pollen Zone V; otherwise the Boreal is linked with Pollen Zone VI, which is sometimes subdivided to give Zones VIa, VIb, and VIc, according to the most abundant tree pollen represented. For Britain, the Boreal period is significant as the last period in post-glacial times in which Britain was joined to mainland Europe by a land bridge across the Dover Strait.

boreal zone *See* circumboreal distribution.

Borhyaenoidea (infraclass Metatheria, order Marsupialia) Extinct superfamily of S. American marsupial carnivores, the largest about the size of a wolf, which lived from the Palaeocene to Pliocene. Similarities between borhyaenoids and *Thylacinus* (the Tasmanian 'wolf') suggest that marsupials originated in S. America and moved across Antarctica to Australia. Borhyaenoids became extinct following the colonization of S. America by placental mammals.

Borneo camphor *See Dryobalanops*.

Borneo ironwood (belian, *Eusideroxylon zwageri*) *See Eusideroxylon*.

bornhardt Rounded, often isolated, hill developed in massive rock and found in the humid tropics. Its shape is controlled by large-scale exfoliation or sheeting joints. Such hills are sometimes called 'sugar-loaf' hills, after the granitic dome of the Sugar Loaf, Rio de Janeiro, Brazil.

bornite (peacock ore) Common copper mineral, specific gravity 5.0–5.1, hardness 3, chemical composition Cu_5FeS_4, which occurs in hydrothermal veins, in zones of secondary enrichment, and as a primary mineral in igneous rocks and pegmatites. It is distinguished by its iridescent colours, solubility in nitric acid, and its alteration to secondary copper minerals. It is reddish-brown to various shades of purplish blue, the colours iridescent on tarnished surfaces, and it has a pale grey streak and a metallic lustre. It crystallizes in the cubic system. The crystals are rough cubes, rhombododecahedra, and also massive. It is an ore for copper.

boron Element (symbol B), commonly found as boric acid in soil solution, which is essential for healthy plant growth. It forms complexes with many organic molecules and is involved in phenolic metabolism and in membrane function, but its primary role is not yet understood.

Boronia (family Rutaceae, tribe Boroniaceae) Genus chiefly of shrubs less than a metre high, with strongly aromatic leaves, and four-petalled, star-like flowers which are usually pink. They are found on heathland and in dry sclerophyll forests in shady places. There are 70 species, endemic to and found throughout temperate Australia.

Borrelia (family Spirochaetaceae, order Spirochaetales) Genus of flexible, spirally-shaped bacteria, which are anaerobic chemo-organotrophs. There are many species, found mainly on mucous membranes in humans, other mammals, and birds. Some are pathogenic: certain species cause relapsing fever and are transmitted by ticks or lice.

Bos (cattle) *See* Bovidae.

boscus (subboscus) Wood or undergrowth produced by coppice growth.

bosky Applied to a landscape that comprises open farmland with isolated trees and small patches of woodland.

boss Discordant igneous intrusion that has roughly vertical sides and a subcircular outcrop, and the diameter of which is less than 25 km.

Bostrichidae (branch borer, limb borer, shot-hole borer; class Insecta, order Coleoptera) Family of black or brown beetles, 3–20 mm long, with the head tucked under a rounded, rugose thorax. The elytra are sharply declined at the rear, with several projecting, horizontal spines. The antennae have a loose club. Larvae are curved, white, and fleshy, with a tiny head and enlarged thorax. They bore into felled or dying trees. There are many generations per year. *Dinoderus minutus* (bamboo borer) causes damage to bamboo, cane, and wickerwork products; originally from the Far East, it is now widespread. *Rhyzopertha dominica* (lesser grain borer) is a serious pest of stored grain. There are 434 species, largely tropical.

Botaurus (bitterns; family Ardeidae) Genus of brown, buff, and black, cryptically patterned birds, with long, pointed bills, and long legs. They inhabit reed beds and feed on fish, amphibians, and small mammals. They nest on a platform of reeds. They have a loud, booming call. There are four species,

found in Eurasia, Africa, Australia, and the Americas.

bot fly *See* Gasterophilidae; and Oestridae.

Bothidae (left-eye flounders; class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Large family of mainly marine, shallow-water flatfish, in which both eyes lie on the left side of the body. The dorsal fin originates in front of the eyes and spines are absent from all the fins. Many species are of small to moderate size. Others, e.g. *Scophthalmus maximus* (European turbot) and *Paralichthys californicus* (California halibut) are of considerable economic value. Flatfish are known for their remarkable colour adaptations to the prevailing background. There are about 425 species, with worldwide distribution.

Bothriocephalidea (phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms which possess a relatively simple scolex. All inhabit three hosts during their development.

Bothriocidaroida (phylum Echinodermata, class Echinoidea) Small order of echinoderms which have two columns of perforate plates and one column of imperforate plates. Traditionally they are regarded as the ancestral stock of all echinoids, but recently it has been suggested that they are more closely related to ophiocistioids and holothuroids. There are only three genera, ranging in age from Middle Ordovician to Upper Silurian.

bothrium In some Cestoda, a sucking groove on the 'head'.

Botia macracantha (clown loach) *See* Cobitidae.

Botrychium (family Ophioglossaceae) Genus of eusporangiate ferns with both the sterile and fertile blades of the leaf pinnately lobed or divided, the massive sporangia subsessile on the fertile pinnae, opening by a transverse slit without true annulus. There are about 30 species, cosmopolitan in distribution, but most are northern temperate.

botryoidal tissue In Hirudinea, parenchyma and connective tissues that invade the coelom.

Botrytis (class Hyphomycetes) Form-genus of fungi which form septate mycelia and produce dark-coloured conidia. They are saprotrophic on plant debris, and also parasitic in plants, causing a number of important diseases. *B. cinerea* causes grey mould on a wide range of plants and fruits; *B. allii* causes neck-rot of onions.

'bottlebrushes' *See Melaleuca*.

bottle-nosed dolphin (*Tursiops truncatus*) *See* Delphinidae.

bottle-nosed whale (*Hyperoodon ampullatus*) *See* Ziphiidae.

bottomset beds 1 The part of a cross-bedded set of sediments that forms at the base of the downcurrent or lee-side of a dune or ripple form structure. 2 Offshore clays formed at the base of a prograding deltaic sequence. *See also* delta.

bottom water The water mass that lies at the deepest part of the water column in the ocean. It is relatively dense and cold, e.g. the North Atlantic bottom water has a temperature of 1–2 °C. Bottom-water circulation is slow-moving and is greatly influenced by sea-bed topography.

botulism Severe, often fatal disease caused by the ingestion of foods contaminated with the botulinum toxin produced by the bacterium *Clostridium botulinum*. This toxin is one of the most potent known. Symptoms of botulism include nausea, constipation, dizziness, and dryness of the throat; later neurological disorders such as blurred vision and weakness develop, and finally death may occur due to paralysis of the respiratory system. Foods commonly responsible for cases of botulism are improperly cooked meats. ('Botulism' derives from the Latin *botulus*, 'sausage'.)

boudinage Minor structural feature in which competent strata resemble a series of sausages or 'boudins'. They are formed by the stretching or squeezing of the competent units which, unlike incompetent ones, cannot deform plastically. As deformation proceeds within the competent layer local thickening and thinning occurs, giving pinch and swell structures.

Bougainvillea (family Nyctaginaceae) Genus of spiny, sarmentose shrubs or climbers, producing flowers in threes, surrounded by three coloured bracts. They are extensively cultivated, with numerous varieties. There are 18 species, native to tropical America.

boulder clay Glacial deposit consisting of boulders of varying size in a clay-dominated matrix and laid down beneath a valley glacier or ice sheet. Typically it is unstratified and unsorted, and characterized by rock types derived from the country crossed by the depositing glacier. *See also* till.

Bouma sequence Idealized sequence of sedimentary structures observed in turbidity-current deposits. It is named after the geologist, A. H. Bouma, who first emphasized its generality (*Sedimentology of some flysch deposits*, Elsevier, Amsterdam, 1962). The lowest unit, A, a massive or graded sand, is overlain progressively by the B (lower division of parallel lamination), C (ripple or convolute laminations), D (upper division of plane parallel laminations), and E (pelagic shale) units. Examples showing the entire sequence are not common. The sequence can be interpreted in terms of deposition under waning current conditions.

boundary current Northward- or southward-directed ocean-water current which flows parallel and close to a continental margin. Such currents are caused by the deflection of eastward- and westward-flowing currents by the continental land masses. Boundary currents on the western margin of ocean basins, such as the Gulf Stream and the Kuroshio current, are deep, narrow, fast-moving currents; while currents along the eastern boundaries, such as the Canaries current and the California current, tend to be relatively shallow, broad, diffuse and slow-moving.

boundary layer General term used to describe the atmospheric layer up to about 100 m above the ground surface, where the air flow is largely

conditioned by the frictional effects of the surface. Mean velocities in the boundary layer are typically less than the free-stream values. *See also* planetary boundary layer.

boundary-zonal Time line based on either the appearance or the disappearance of a key species or fauna. Associated faunas and sediments may transgress a zonal boundary.

bound water Water molecules present in a shell of hydration surrounding an ion. Typically, an ion of either charge will bind electrostatically four to six water molecules. Bound water has properties intermediate between those of free water and ice.

Bourgueticrinida (sea-lilies; class Crinoidea, subclass Articulata) Order of articulate sea-lilies (crinoids) in which the compact calyx, or cup, is made up of five basals and five radials only. The column consists of elliptical or rounded ossicles which are united by synarthrial (bearing a fulcral ridge) articulations. Five or ten arms are present. The order first appeared in the Upper Cretaceous.

boutonneuse Disease of humans in which the symptoms include fever, headache, and a rash. The causal agent, *Rickettsia conorii*, is transmitted by ticks.

Bovichthyidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of small, mainly marine fish, restricted to the cooler waters of the southern hemisphere, including oceanic islands, e.g. Tristan da Cunha. A freshwater representative, *Pseudaphritis urvilli* (congolli) of S. Australia, lives in rivers, where it reaches a length of some 35 cm. There are about six species.

Bovidae (oxen, antelopes, gazelles, sheep, goats; order Artiodactyla, suborder Ruminantia, infraorder Pecora, superfamily Bovoidea) The largest by far of the artiodactyl families, including cattle, bison, musk-ox, sheep, goats, antelopes, and allied groups. They are descended from the Oligocene tragulоids, but do not appear as a distinct type until the Miocene. A major diversification followed in the Pliocene. Most are grazers but some are browsers. Horns, present in the male and often in the female, are covered with keratin and are not shed. The feet have two or four digits. Bovidae are of worldwide distribution, the family including *Bison bison* (N. American bison), *Bison bonasus* (European wisent, sometimes known, incorrectly, as the 'aurochs'), *Bos taurus* (all breeds of European cattle), *Bos indicus* (Zebu cattle), *Bos grunniens* (yak), *Capra* goats, domesticated breeds being descended from *C. aegagrus*, the pasang), *Ovis* (sheep, descended from several wild members of the genus), *Ovibos moschatus* (musk-ox), *Taurotragus oryx* (eland), *Aepyceros melampus* (impala), and *Saiga tatarica* (the saiga antelope of Siberia). In all there are 44 genera, with 111 species. The family is sometimes taken to include the family Antilocapridae.

bovine tubercle bacillus (*Mycobacterium bovis*) *See Mycobacterium*.

bovine typhus *See* rinderpest.

Bovoidea (order Artiodactyla, infraorder Pecora) Superfamily comprising two families, Antilocapridae and Bovidae, sometimes grouped together as a single family, Bovidae: the pronghorn (*Antilocapra*) and numerous extinct allied forms have been distinct from the bovids since the Miocene and may have evolved from a cervid line. Bovoids are pecorans with lateral toe digits reduced in some species to a nodule of bone. The upper canines are reduced or absent, the cheek teeth high-crowned. Horns are present, usually in both sexes though more developed in males, and covered with keratin (horn) rather than skin (as in cervids).

bowerbirds *See* Ptilonorhynchidae.

bowfin (*Amia calva*) *See* Amiidae.

bowhead whale (*Balaena mysticetus*) *See* Balaenidae.

bowstring hemp (*Sansevieria zeylanica*) *See Sansevieria*.

box elder (*Acer negundo*) *See Acer*.

boxfish (*Ostracion lentiginosum*) *See* Ostraciontidae.

box model *See* compartment model.

boxwood (*Buxus sempervirens*) *See Buxus*.

BP Before the present.

brachiation In some arboreal Primates, a form of locomotion in which an animal swings hand over hand from branch to branch. In those species in which it is developed fully (species of Hylobatidae, and *Pongo*), apes are said to be able to move more quickly through the trees than a human can walk on the ground below.

Brachinus (bombardier beetle) *See* Carabidae.

brachiolaria In some Asteroidea, a larval form, bearing three pre-oral adhesive processes, which develops from the bipinnaria larva.

brachiole *See* Eocrinoidea.

Brachionichthyidae (warty angler; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of marine fish, differing from the related frogfish (Antennariidae) in having a thick membrane, separate from the rest of the dorsal fin, above the eyes. The pectoral and pelvic fins are arm-like in shape, making the fish more frog-like than the frogfish. There are a few species, found in the southern half of Australia.

Brachiopoda (lamp shells) Phylum of solitary, marine, bivalved, coelomate invertebrates. The shell is chitinophosphatic or calcareous. Brachiopods are attached to the sea-bed by a muscular stalk (pedicle), or are secondarily cemented, or are free-living. Usually they consist of a larger, pedicle (ventral) valve and a brachial (dorsal) valve, lined by reduplications (mantle lobes) of the body wall which enclose the large mantle cavity. They are bilaterally symmetrical about the posterior–anterior mid-line of the valves. The feeding organ (lophophore) surrounds the mouth and is covered by ciliated tentacles. The alimentary canal is divided into oesophagus, stomach, and intestine, with or

without an anus. The nervous system is subepithelial, consisting of a ganglionate circum-oesophageal ring. The excretory organs are one or two pairs of metanephridia also acting as gonoducts. The circulatory system is open, with the contractile vesicle (heart) near the stomach. Brachiopods first appeared in the Lower Cambrian, and since then have undergone numerous radiations, the first involving the inarticulate brachiopods. The articulate groups became more important after the Cambrian. Many of the larger articulate groups, including the strophomenids, orthids, and spiriferids, are now extinct.

Brachiopterygii (class Osteichthyes) Group (subclass) of bony fish including the curious bichirs (*Polypterus* species) and reedfish (*Calamoichthys* species) of central Africa. This interesting group of fish possesses a number of primitive and specialized features, e.g. a series of spinous dorsal finlets, ganoid scales, lobate pectoral fins with special skeletal supports, a spiracle, a spiral intestinal valve, and a pair of ventral lung-like air bladders. The systematic position of the bichirs is not yet certain: the 11 living species, grouped together as the order Polypteriformes, have also been included in the subclass Actinopterygii.

brachycardia Condition in which the heart rate is reduced substantially.

Brachycera (class Insecta, order Diptera) Suborder of the Diptera whose members are recognizable from their wing venation and porrect palps. With one exception (Stratiomyidae) all Brachycera larvae have the head retractile within the thorax. The antennae usually have fewer than six segments, with exceptions where segments have fused as a secondary feature. There are 16 families.

Brachychiton (family Sterculiaceae) Genus of trees that are deciduous only at flowering, which is irregular. Their leaves are entire or lobed, and the bell-shaped flowers are cream, pink, or red. There are 18 species, 17 of them found in Australia and two in New Guinea. They occur widely in arid zones as well as in rain forest.

Brachycome (family Compositae, tribe Astereae) Genus of small, annual and perennial herbs. They have simple or divided leaves, and flowers, about 3 cm in diameter, that are white, pink, blue, purple, or yellow. There are 60 species, mainly restricted to Australia.

Brachydanio rerio (zebra danio) *See* Cyprinidae.

brachydont Applied to teeth in which the crowns are low or short and the roots well developed, with narrow canals.

Brachygalba (jacamars; family Galbulidae) Genus of birds that are smaller and shorter-tailed than other jacamars. They are dull-brown and black, glossed with green, and are found in open woodland. They are insectivorous, and nest in tunnels. There are four species, found in Panama and tropical S. America.

Brachyloma (family Epacridaceae) Genus of small, bushy shrubs that have small, flat, pointed leaves. The flowers are small, solitary, and axillary, and white or red. There are five sepals and five petals. The corolla is tubular with spreading lobes and a ring of hairs, and the five stamens are attached to the tube. The fruit is a small drupe. There are seven species, endemic to Australia, and found mostly in the west.

Brachypteraciidae (groundrollers; order Coraciiformes) Family of brightly-coloured, long-legged, short-winged birds, with the anterior toes joined at the base. They are ground-dwelling in humid forest, except for *Uratelornis chimaera* (long-tailed groundroller) which inhabits arid desert. They are insectivorous, also taking small amphibians and reptiles. There are three genera, containing five species, found only in Madagascar.

brachypterous Applied to insects in which both pairs of wings are reduced.

Brachypteryx (shortwings; family Turdidae) Genus of small, robin-like birds with short wings and short tails. They are skulking, and found in dense forest undergrowth. They are insectivorous, and nest in moss or in holes in trees or in the ground. There are six species, found in India, SE Asia, Indonesia, and the Philippines.

Brachyrhamphus marmoratus (marbled murrelet) *See* Alcidae.

Brachythecium (order Hypnobryales) Genus of pleurocarpous mosses in which branching may be irregular or pinnate. The leaves are imbricate to spreading, and each has a nerve extending at least half-way up the leaf. The capsule is inclined to horizontal, ovoid to cylindrical, and borne on a deep-red seta. *Brachythecium* is a cosmopolitan genus with about 300 species, found in a wide variety of habitats. *B. rutabulum* is common in all but the most acid habitats, particularly in damp, shady situations. It grows on rocks, soil, wood, and often in lawns. Its shoots grow to 12 cm. Branching is irregular, with the branches erect, ascending, or arcuate. The leaves are 2–3 mm long, broadly oval, and tapering to a sharp point. They are bright green to yellowish-green, and glossy.

bracken *See Pteridium*.

bracket fungus Common name for a fungus that forms bracket-like or shelf-like fruit bodies on trees, logs, etc.

brackish Applied to water that is saline, but less so than sea-water. According to the Venice system brackish waters are classified by the chlorine they contain and divided into zones. The zones, with their percentage chlorinity (mean values at limits) are: euhaline 1.65–2.2; polyhaline 1.0–1.65; mesohaline 0.3–1.0; alpha-mesohaline 0.55–1.0; beta-mesohaline 0.3-0.55; oligohaline 0.03–0.3; fresh water 0.03 or less.

Braconidae (suborder Apocrita, superfamily Ichneumonoidea) Family of insects that are distinguished from the Ichneumonidae on the basis of their wing venation. Braconids are small (2–15 mm long), parasitic wasps, mostly brownish or black. Eggs are laid in or upon the body of the host insect,

which is consumed before the parasite pupates (pupation sometimes occurring outside the host body in a silken cocoon). Braconids parasitize the larvae of Lepidoptera, Symphyta, Coleoptera, Diptera, etc., and some are important as biological-control agents. Species belonging to the common genus *Apanteles* parasitize lepidopteran larvae and chrysalids.

bract Leaf, usually much reduced or modified, which subtends a flower or inflorescence in its axis.

bracteate Bearing bracts.

bracteole Little bract borne on the flower stalk above the bract and below the calyx.

Bradoria Primitive crustacean recorded from the Lower Cambrian of Europe and N. America. It is an early member of the Archaeocopida, a Cambrian order of ostracodes.

Bradypodidae (tree sloths; order Edentata, infra-order Pilosa, superfamily Bradypodoidea) Family of edentates (toothless mammals) fully adapted for arboreal life and unable to walk on the ground: they use their limbs to hang upside-down from branches. The head is short and rounded. They are not actually toothless, but the five teeth have no enamel and by growing continuously provide a grinding surface. The forelimbs are longer than the hind limbs, the digits bearing hooked claws used in hanging. The tail is short. The fur is long, coarse and grooved; cyanobacteria grow in the grooves, giving the animals a greenish colour. There are six cervical vertebrae in *Choloepus*, nine in *Bradypus*. The stomach is large and chambered, the rectum very large, retaining faeces for several days. All movements are slow. The body temperature is low and variable, sloths neither shivering nor sweating, but dying from hypothermia at temperatures below 40 °C. They are distributed throughout the forests of tropical America. There are two genera, and six species.

Bradypodoidea (tree sloths; order Edentata, infra-order Pilosa) Superfamily comprising the family Bradypodidae (tree sloths). These animals are unknown as fossils, probably because their humid tropical habitat fails to preserve them after death. Structurally they appear to be related to the ground sloths of the superfamily Megalonychoidea.

bradytelic evolution One of three types of evolutionary rates within groups. In this instance the rate is exceedingly slow, and is manifest by slowly-evolving lineages which survive much longer than would normally be expected. Living fossils, e.g. the coelacanth, represent the low end of the bradytelic range; while the better-known groups that have remained relatively stable with time include opossums and crocodiles.

braided river River whose plan consists of a number of small channels separated by bars. The latter may be vegetated and stable (e.g. the eyots of the River Thames, England), or barren and unstable (as at glacial margins, where rapid changes occur).

brain In animals, the anterior section of the central nervous system, associated with the aggregation of sense organs anteriorly.

brain fungus Common name for the fruit body of the fungus *Sparassis crispa*.

brake Area of bracken, scrub, or underwood.

Brama brama (Ray's bream) *See* Bramidae.

brambling (*Fringilla montifringilla*) *See Fringilla*.

Bramidae (Atlantic pomfret, Ray's bream; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of deep-bodied, moderate to large oceanic fish. Oval in outline, the body shows long dorsal anal fins, a forked tail, and large, wing-like pectoral fins. *Brama brama* (Ray's bream or Atlantic pomfret), reaching a length of up to 70 cm, lives in depths of 100 m or more. There are about 18 species, found in all but polar seas.

branch borer *See* Bostrichidae.

branched hydrocorals *See* Stylasterina.

branchiae In some aquatic invertebrates, thin-walled extensions of the body wall which function as gills.

branchial arch (branchial basket) Gill arch; in aquatic vertebrates, the skeletal structure that supports the gills. *See also* gills (of fish).

branchial basket 1 *See* branchial arch. 2 *See* rectal gill.

Branchiopoda (gill-footed shrimps; phylum Arthropoda, subphylum Crustacea) Diverse class of small, mainly freshwater, filter-feeding crustaceans, all characterized by flattened, leaf-like, trunk appendages in which the coxa bears a flattened epipodite which functions as a gill. The Branchiopoda includes the Anostraca (fairy shrimps), the Notostraca (tadpole shrimps), the Conchostraca (clam shrimps), and the Cladocera (water fleas). Many are pink or red owing to the presence of haemoglobin. They are often inhabitants of temporary bodies of water, and have drought-resistant eggs. There are 800 species.

Branchiostegidae Older name for a family of fish now known as Malacanthidae.

Branchiostomidae (lancelets; order Amphioxiformes) Family of small, fish-like, marine, coastal animals. Lancelets are the only living representatives of the subphylum Cephalochordata. Although definitely not true fish, lancelets (e.g. *Branchiostoma lanceolata*) are considered fairly close to the vertebrate ancestral lineage. They have an almost transparent body, no eyes or brains, a permanent notochord, and a dorsal hollow nerve cord; and they spend most of their lives buried in the beds beneath the world's oceans.

Branchiura (phylum Arthropoda, subphylum Crustacea) Small class of crustaceans, all of which are parasites, and which differ from the copepods in having a pair of sessile compound eyes, and a large, shield-like carapace covering the head and thorax. Branchiurans are common, blood-sucking ecto-parasites on the skin or in the gill cavities of marine

and freshwater fish and a few amphibians. Attachment to the host is via a large, claw-like modification of the first antennae, and by a pair of large suckers derived from the bases of the first maxillae, the rest of the maxillae being vestigial. A sucking mouth cone is formed from the labrum and labium. In *Argulus* there is a hollow spine in front of the mouth cone, which pierces the skin of the host and injects a supposedly poisonous secretion. There are no maxillipeds, and the second maxillae are uniramous well developed, with terminal claws. There are four large, biramous, thoracic appendages, armed with swimming setae. These are used when swimming between hosts. There are 75 species.

Branta (geese; family Anatidae) Genus of medium to large geese. They are vegetarian, ground-nesting, and migratory. *B. canadensis* (Canada goose) has been introduced to Europe. *B. sandvicensis* (Hawaiian goose or ne-ne) is more terrestrial and non-migratory, having reduced webbing and short wings. There are five species, found in Europe, Asia, N. America, and Hawaii.

Branta canadensis (Canada goose) *See Branta*.

Branta sandvicensis (Hawaiian goose, ne-ne) *See Branta*.

brash Cut off the lower branches of young trees, especially conifers, in plantations.

Brassica (family Cruciferae) Genus of annual to perennial herbs that have tap roots and erect, branched stems. The flowers are usually yellow, and are always four-petalled, the elongated fruit having a lower part (containing several seeds) that opens by two valves each with one strong vein, and an upper, indehiscent part (the beak) with 0–3 seeds. Several are important vegetables (cabbage, turnip, etc.) or sources of useful oil (rape, black mustard, etc.). There are about 40 species, whose distribution is centred on the Mediterranean.

Brassolinae (owl butterflies) A subfamily of the Nymphalidae.

Braula caeca (bee louse; order Diptera, family Braulidae) Small, wingless fly which lacks halteres. It is highly adapted for clinging to the body of *Apis mellifera* (honey bee) and for using bees as a mode of transport to gain access to hives.

Braulidae (bee lice; class Insecta, order Diptera, suborder Cyclorrapha) Family of abnormal flies which lack wings and resemble members of the Hippoboscidae. The antennae are set in lateral grooves, and the eyes are reduced in size. The thorax appears to be joined to the abdomen. The tarsi are adapted to cling to the bodies of Hymenoptera, especially bees. Their eggs are laid near honey- or pollen-storage cells inside a bee nest, and the larvae of the bee lice feed on these substances and pupate within the nest of the host. The pupa is unique among the Cyclorrapha in being enclosed in the unmodified last (final instar) larval cuticle, and not a true puparium. Only five species have been described so far.

Braun-Blanquet, Josias (1884–1980) Swiss ecologist who devised the most widely used of European phytosociological methods for the description of vegetation communities, and who was generally acknowledged as the foremost authority on such schemes. He developed the framework for his system in his doctoral study of the vegetation of the central Cévennes (1915), and the fully-developed method was published in his textbook *Pflanzensoziologie* (Springer Verlag, Berlin, 1928) which he revised and updated for a third, enlarged edition published in 1964. The book is an excellent source of information on all European phytosociological work. He worked at, and for many years was director of, the Station Internationale de Géobotanique, Méditerranéenne et Alpine (SIGMA) at Montpellier, France. *See also* Zurich–Montpellier school of phytosociology.

braunite Mineral, specific gravity 4.7–4.8, hardness 6.0–6.5, chemical composition $3Mn_2O_3MnSiO_3$. It occurs in hydrothermal veins together with other manganese oxides, and also as a secondary mineral; and as a result of metamorphism of manganese-bearing sediments. It is very similar to other manganese minerals, but is soluble in hydrochloric acid, when it leaves a residue of silica. It is brownish-black to steel-grey, and has a brown-black streak, and a sub-metallic lustre. It crystallizes in the tetragonal system. The crystals are pyramidal, and it can also be massive and granular. It is an ore for manganese and is used in steel-making.

braxy Severe, often fatal, disease of lambs, whose causal agent is a bacterium, *Clostridium septicum*, which appears to infect the lamb via its fourth stomach (the abomasum).

brazes Small pieces of charcoal used traditionally for the refining of bars of iron.

Brazil current Warm water, forming the oceanic boundary current that flows southward along the Brazilian coastal margin. It is marked by its high salinity (36–37 parts per thousand) its low velocity, and its shallowness (100–200 m) in comparison to its northern hemisphere equivalent, the Gulf Stream.

brazil-nut (*Bertholletia excelsa*) *See Bertholletia*.

Brazil tulipwood *See Dalbergia*.

brazilwood (*Caesalpinia sappan*) *See Caesalpinia*.

breached anticline Anticline whose core has been opened up (breached) by erosion, so creating a depression. Breaching is aided by weakness at the crest of the anticline, reflecting tensional forces at the time of folding, and by a softer lower stratum. *See also* inverted relief.

breadfruit (*Artocarpus altilis*) *See Artocarpus*.

bread mould Loosely, any mould found growing on bread, e.g. red bread mould is *Neurospora sitophila*.

breadnut (*Brosimum alicastrum*) *See Brosimum*.

breakage and reunion In genetics, the established model of crossing-over by the physical breakage and crosswise reunion of broken chromatids during

the pairing of homologous chromosomes at the prophase stage of meiosis. The points at which chromosomes cross over are termed chiasmata. The result of crossing-over is the mutual exchange between chromatids of parts that contain corresponding loci.

breaker Wave that is collapsing or breaking as a result of the wave approaching the shore and reaching shallower water. The decreasing water depth causes the wavelength and speed to decrease and the wave height to increase. Consequently wave steepness increases and the wave becomes unstable: it breaks when the wave height is about 0.8 times the water depth. Several types of breaker have been described, e.g. spilling breakers (in which the wave breaks forward, with broken water spilling down the front of the wave), and plunging breakers (in which the wave crest curls over a large air pocket and falls vertically into the trough).

breccia Coarse, clastic, sedimentary rock, the constituent clasts of which are angular. 'Breccia' literally means 'rubble' and implies a rock deposited very close to the source area. The term may also be applied to angular volcanic rocks from a vent (vent breccia).

breckland Distinctive locality in SW Norfolk and NW Suffolk, England, with a mosaic of grass heath and *Pteridium aquilinum* (bracken) and *Calluna vulgaris* (heather, ling) communities. Pollen analysis has demonstrated that the breckland was one of the first areas in Britain to be permanently cleared of woodland by Neolithic farmers.

breed Artificial mating group derived (by humans) from a common ancestor, usually for agriculture (e.g. domesticated animals and crop plants), or for genetic analysis, or for pleasure (e.g. cats and dogs).

breeding dispersal *See* philopatry.

breeding size The number of individuals in a population involved in reproduction during a particular generation. It does not include the non-breeding element of the population.

breeding true Producing offspring with phenotypes identical to those of the parents. Homozygous individuals necessarily breed true (unless mutations arise), whereas heterozygotes rarely do so.

breeze 1 Relatively light wind, often of convective origin. The term also includes particular local air movements, e.g. mountain, land, and sea breezes. *See also* Beaufort scale. 2 (entomol.) *See* Tabanidae.

Bregmacerotidae (codlets; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Small family of marine, oceanic, warm-water fish related to the codfish. They are easily identifiable by their elongate body, deeply-notched dorsal and anal fins; the first dorsal ray reduced to one spine on the head, and long; and outer pectoral-fin rays trailing beside the body. The seven species are of worldwide distribution. Although not a true deep-sea fish, the Indo-Pacific *Bregmaceros macclellandi*, up to 12 cm in length, has been caught at depths exceeding 500 m.

Brenthidae (class Insecta, order Coleoptera) Family of narrow beetles, up to 40 mm long, often with an exceptionally lengthened head and rostrum; the elytra of some species comprise only one-quarter of the total body length. Many are sexually dimorphic. The females' long rostrum is used for boring into wood in which eggs are laid; the jaws are tiny. Males have a broad rudimentary rostrum but large jaws possibly for holding the female during mating. Larvae are fleshy, with short legs, and are found in decaying wood. There are 1230 species, largely of tropical woodland.

Breviceps adspersus (rain frog, shorthead; order Anura (Salientia), family Microhylidae) Species of burrowing anuran, a small (about 4 cm long), round-bodied frog with a short head, and warty skin. They appear in large numbers after rain. The egg mass is laid in a damp burrow. Froglets develop without an aquatic phase. The species is found in southern Africa.

breviconic Applied to the conch of a cephalopod when it is short and expands quickly. The aperture is quite wide.

Brevoortia tyrannus (menhaden) *See* Clupeidae.

brewers' yeast Strains of *Saccharomyces cerevisiae* used in brewing beer. *Compare* bakers' yeast.

brezales *See* Mediterranean scrub.

brickearth Fine-grained silty deposit occurring in SE England. Of complex origin, it probably resulted from the reworking of loess, either by hillslope washing or by redeposition in standing water.

Brillouin index Adaptation of the Shannon–Wiener diversity index, used when the assumption that all species present are well represented in the sample under consideration is not valid.

Brill–Zinsser disease Mild form of typhus fever; it results from the reactivation of the pathogen remaining in the body from a previous attack of typhus.

brimstones *See* Pieridae.

brine shrimps *See* Anostraca.

Brisingina (starfish; subclass Asteroidea, order Euclasterida) Suborder of starfish (asteroids) which possess numerous long, thin arms, sharply demarcated from a central disc. The upper (dorsal) surface of the disc contains four skeletal elements. The Brisingina first appeared in the Oligocene.

bristlebirds *See* Acanthizidae.

bristlecone pine *See Pinus aristata*.

bristle-ferns *See Trichomanes*.

bristlemouth *See* Gonostomatidae.

bristletail (subclass Apterygota, order Thysanura) Common, collective name for thysanurans, which is sometimes extended to include the Archaeognatha, and which is applied incorrectly to diplurans.

bristleworms *See* Polychaeta.

brittle-stars *See* Euryhalina; Gnathophiurina; Ophiomyxina; Ophiurida; Ophiuroidea; and Phrynophiurida.

broad bean (*Vicia faba*) *see Vicia*.

broadbills *See Eurylaimus*; Eurylaimidae; and *Smithornis*.

broad-bodied chaser (*Libellula depressa*) *See* Libellulidae.

broad-leaved evergreen forest North of the tropics, broad-leaved forests are mainly deciduous, the evergreen variants being restricted to the coastal plain of the Gulf of Mexico, S. Japan, and central China. South of the tropics, however, the broad-leaved forests are mainly evergreen, the only exception occurring in Chilean Patagonia. This forest type requires plentiful rainfall, well distributed throughout the year.

broad-leaved mid-latitude forest Extra-tropical formation-type dominated by hardwoods, which are predominantly deciduous in the northern hemisphere and evergreen in the southern hemisphere.

broad-leaved-tree savannah Where moisture is available for lengthy periods in the year on S. American savannahs, a scattering of mainly broad-leaved trees occurs amongst the grasses. These broad-leaved-tree savannahs are known by a variety of names, e.g. 'campos', 'llanos'.

broad-leaved woodland Woodland in which not more than 20% of the standing trees are coniferous.

bromatia Swellings that develop at the tips of hyphae of fungi cultivated by parasol ants; bromatia serve as food for the ants.

Bromeliaceae Distinctive family of monocotyledons with no close relatives, most of which are herbs and epiphytes, a few being terrestrial. Most have leaves crowded with an amplexicaul base forming a tank from which water is absorbed. The inflorescence is terminal, sometimes with showy bracts. The flowers are regular, and trimerous. The fruit is a berry, or capsule. There are 50 genera, with 2000 species, almost entirely confined to the New World, and mostly tropical.

bronchitis Inflammation of the bronchi. Bronchitis may result from the inhalation of dust or irritating fumes, or it may be due to microbial infection. It may also occur as a complication of another disease, e.g. measles or influenza.

Brontosaurus Synonym of *Apatosaurus*. The latter means 'deceptive-lizard' and is the older of the two names.

brontothere *See* Brontotheriidae.

Brontotheriidae (brontotheres, titanotheres; class Mammalia, order Perissodactyla) Suborder (ranked by some authorities as a family of the suborder Hippomorpha) of rhinoceros-like animals which flourished in the Eocene and Oligocene, and then became extinct. Probably they appeared first in N. America, but they spread to Asia and some lived in E. Europe. Brontotheres were large, some reaching 2.4 m at the shoulder (as large as modern elephants). The skull was long and low, the brain small. Bony horns were present in later forms, often large and presumed larger in males than females, carried as a pair, side by side on the front of the head. Some, e.g. *Brontotherium*, had Y- or V-shaped horns on their noses. The limbs were graviportal (short and massive). The teeth were primitive, the incisors and a premolar absent in some forms, the molars large, low-crowned, bunolophodont. The brontotheres seem to have evolved rapidly to large size, but their teeth must have restricted their diet to soft plant material, perhaps making them vulnerable to minor environmental changes.

brookite Mineral, specific gravity 4.1, hardness 5.5–6.0, chemical composition TiO_2, named after the British mineralogist H. J. Brooke. It occurs as an accessory mineral in igneous and metamorphic rocks, and also in hydrothermal veins. Brookite, anatase, and rutile are all polymorphs of titanium dioxide. It is reddish-brown to brownish-black, and has a white streak and a metallic lustre. It crystallizes in the orthorhombic system. The crystals are normally platy and tabular.

Brooksellida (class Protomedusae) The only order in its class, with the characteristics of the class, and best known from Middle Cambrian fossil medusoids from Alabama, USA.

Brosimum (family Moraceae) Genus of trees wnose flowers are aggregated in heads of one sunken female and many males. The fruit is an achene embedded in the fleshy receptacle. The achene of *B. alicastrum* is the breadnut. *B. galactodendron* is the cow-tree or milk-tree of Venezuela. It produces copious latex of appearance similar to cow's milk and is used as a substitute for this. There are 50 species, occurring in temperate and tropical S. America.

brotula *See* Ophidiidae.

Broussonetia (family Moraceae) Genus of trees, which are dioecious, the female flowers being borne in heads. They produce multiple fruit. The inner bark of *B. papyrifera* contains fibre good for making paper (paper mulberry, Japan) and tapa cloth. There are seven or eight species, occurring from E. Asia to Polynesia.

brown algae Common name for seaweeds of the class Phaeophyceae, although not all members are strictly brown in colour: most are olive-brown when wet, becoming almost black on drying.

brown dottyback (*Pseudochromis fuscus*) *See* Pseudochromidae.

Brownea (family Leguminosae, subfamily Caesalpinoideae) Genus of small trees notable for their limp tassels of red or white young leaves. There are 25 species, occurring in tropical America.

brown earth Freely-draining, and only slightly horizonated, soil-profile type. It has a mull humus in the surface horizon and very little differentiation of horizons below. Brown earths are well-weathered and slightly leached soils, with a Cambic horizon in the middle part of the profile (also known as braunerde and now included in the Inceptisols of the USDA Soil Taxonomy).

brown forest soil Little used soil-profile term that has been applied to both acid brown earths and brown podzolics.

Brownian motion Random movement of small particles dispersed in a colloidal solution or suspension.

brown oak 1 Wood from an oak tree that has been infected with *Fistulina hepatica* (beefsteak fungus). The wood has a rich, dark brown colour. Although mechanically weaker than wood from uninfected trees, it is nevertheless highly prized by cabinet-makers for decorative purposes. 2 Disease of oak trees caused by *Fistulina hepatica*.

brown podzolic soil Freely-draining, leached soil profile that has developed acid surface horizons, a mor surface humus, and a clearly visible enrichment of translocated iron oxide in the middle, or B, horizon. The profile has been leached to the early stage of podzolization, identified by the movement down-profile of iron and aluminium compounds.

brown recluse spider *See Loxosceles reclusa*.

brown rot 1 Very common disease of fruit caused by fungi of the genus *Sclerotinia* (usually *S. fructigena*). Fruits susceptible to it include apples, pears, cherries, plums, etc. Initially, soft brown patches appear on the fruit, often at a site of injury, and these gradually spread until the whole fruit is affected. Fungal conidia are produced from small, pale-coloured, cottony patches which typically appear on the rotting fruit. 2 Type of timber decay in which the wood turns a reddish-brown colour and becomes cracked and eventually crumbly in texture. Fungi that cause brown rots are usually unable to break down the lignin component of wood.

browns *See* Satyrinae.

browse wood Thin branches of trees that are fed to cattle and deer in winter.

Brucella Genus of bacteria not assigned to a taxonomic family. The cells are ovoid or shortly rod-shaped, and are Gram-negative. They are chemo-organotrophic, and can grow only in the presence of air. There are several species, found as parasites and pathogens in a range of mammalian hosts. *B. abortus* can cause abortion in cattle and can also infect humans.

brucellosis Disease of humans and certain other animals (e.g. cattle, pigs, and goats), caused by species of *Brucella*. In humans the disease (also called undulant fever) is usually contracted from infected animals, e.g. via raw (unpasteurized) milk. Symptoms include fever, headache, and pains in muscles and joints. In other animals, particularly cattle, infection of a pregnant animal may result in abortion ('contagious abortion').

Bruchidae (seed weevils; class Insecta, order Coleoptera) Family of small, compact beetles, 1.5–5 mm long, with the head curved under the body. The elytra are dark, with a pattern of white or yellow hairs. Bruchidae are a common pest of leguminous crops. Eggs are laid on developing seeds. The larva is fleshy, grub-like, and completes its development inside a single seed. *Bruchus pisorum* attacks only growing peas, while *Acanthoscelides obtectus* will oviposit in dried peas in storage. There are 1200 species. They are also known, incorrectly, as pea weevils and bean weevils (*see* Curculionidae).

brucite Mineral, specific gravity 2.4, hardness 2.5, chemical composition $Mg(OH)_2$, named after the nineteenth century American mineralogist A. Bruce. It can occur in metamorphosed limestone, and also in hydrothermal veins together with calcite, talc, and serpentine. It is distinguished by its softness, foliated habit, and ready solubility in hydrochloric acid. It can be white, shades of pale grey, blue, or green, and it has a white streak, and a pearly to waxy lustre. It crystallizes in the trigonal system. The crystals are normally broad and tabular, but the mineral can also be fibrous, massive, and foliated.

Brückner cycle Tendency for the cyclical recurrence of runs of wet years at about 35-year intervals, with warmer and drier years in between, reported in 1890 by A. Brückner. Much attention was paid to it for a time, but its operation is obscured by the greater magnitude of the irregular year-to-year variations, and by cyclical recurrences of other periods.

Bruguiera (family Rhizophoraceae) One of the principal genera of trees of mangrove forests, having roots with erect pneumatophores, and a trunk without stilt roots. They are viviparous. There are six species, occurring in the tropics from E. Africa to Polynesia.

Brunonia australis (blue pincushion) *See* Brunoniaceae.

Brunoniaceae Monotypic family, comprising *Brunonia australis*, blue pincushion. It is a small herb with a rosette of leaves. The flowers are borne terminally on long stems in densely clustered, hemispherical, bracteate heads. They are regular and pentamerous. The five sepals are united in a lobed tube, and the five petals are narrow and not winged. The ovary is superior and enclosed in the hollow receptacle. The fruit is a small nut. The family is related to Goodeniaceae. It is endemic to Australia and Tasmania and present throughout temperate regions of the country in open communities.

brush-finch *See Atlapetes*.

brush-footed butterflies *See* Nymphalidae.

bruyère (*Erica scoparia*) *See Erica*.

Bryales (subclass Bryidae) Order of medium-sized to large acrocarpous mosses. The leaves are oval to lance-shaped; each usually has a nerve and a border of distinct cells. The capsule is spherical to cylindrical, inclined or drooping, with a double peristome. There are many genera, found in a wide range of habitats.

Bryde's whale (*Balaenoptera edeni*) *See* Balaenopteridae.

Bryidae (class Musci) Subclass of mosses sometimes known as 'true mosses' and sometimes elevated to the level of a class (Bryopsida). They form by far the largest group of mosses. The protonema is typically filamentous, and from it

arise buds which develop into gametophytes. The gametophyte may be acrocarpous or pleurocarpous, and varies greatly in size and shape. The capsule opens by a lid; a peristome may or may not be present. They are found all over the world in most types of habitat.

bryology The study of bryophytes. *See* Bryophyta.

Bryophyta (bryophytes) A division of plants which for most authors includes the mosses (Musci) and liverworts (Hepaticae). Bryophytes differ from algae in that the multicellular gametangium is surrounded by a protective jacket of sterile cells; gametangia of algae are usually unicellular and never have a protective jacket of sterile cells. Although bryophytes lack differentiated water-conducting vessels, and rely largely or entirely on water absorbed from rain falling on the plants, or from a moist atmosphere, they may have simple water-conducting cells in some larger species. They lack true roots, but possess root-like rhizoids which anchor them to a substrate and which can absorb water and minerals. The plants all show a heteromorphic alternation of generations, with a green vegetative gametophyte (the familiar moss or liverwort plant) and a sporophyte which typically takes the form of a (usually stalked) capsule and which is partially or wholly parasitic on the gametophyte. Most bryophytes are land plants and are found worldwide in a range of habitats. They are known from Devonian rocks, but there is no evidence to link them with either the green algae or the more advanced pteridophytes.

Bryopsida Taxon used by some authors as a synonym of Musci, and by others as a class which includes mosses more usually included in the subclass Bryidae, i.e. mosses excluding *Sphagnum* and the Andreaeidae.

Bryozoa (moss-animals) Phylum of small, aquatic, colonial animals, related to the Brachiopoda, many of which possess a well-developed, calcite skeleton which comprises microscopic, box-like divisions, each housing an individual animal possessing ciliated tentacles and a coelom (internal body cavity). Food is collected by the tentacles which surround the mouth and are borne on a ridge called the 'lophophore'. Reproduction takes place by (a) asexual budding, and (b) the release of larvae which give rise to new colonies. Bryozoans have occurred from the Ordovician to the present day. Fossilized branched colonies are common in some rocks. They were important reef builders in the Phanerozoic, and underwent several great radiations.

Bryum (order Bryales) Genus of mosses in which the plants are usually densely tufted. The leaves are ovate or broadly oblong-lanceolate; the cells composing the leaf are uniform and are mainly hexagonal or rhomboid. The capsule is pyriform to sub-cylindrical, horizontal or pendulous, but never erect; the peristome is double. *Bryum* is a large cosmopolitan genus, with about 1050 species, some of which are difficult to distinguish. They are mainly terricolous or saxicolous. *B. argenteum* is easily recognizable on sight: it has a characteristic silvery-green colour, and grows abundantly in many places where little else can grow, e.g. on pavements in towns, roadsides, etc.

Bubbia (family Winteraceae) Genus of small trees, closely related to *Belliolum*. There are 30 species, occurring in New Guinea, Australia, and the SW Pacific.

Bubo (eagle owls; family Strigidae) Genus of large, strong, brown, 'eared' owls. They are nocturnal, with deep, hooting calls. They feed on mammals, birds, and reptiles, and nest on ledges or in abandoned nests. There are 12 species, found in Europe, Asia, Africa, and the Americas.

bubonic plague Commonest form of plague in humans. The characteristic symptom is the bubo: a swollen, infected lymph node. Other symptoms may include fever, prostration, and a rash. The causal agent is *Yersinia pestis* (formerly called *Pasteurella pestis*), a parasite of rodents; it is transmitted to humans by fleas.

buccal cavity Mouth cavity.

buccal force pump Respiratory system typical of the class Amphibia, whereby air is forced into the lungs by raising the buccal cavity floor whilst the valvular nostril is closed. This contrasts with costal respiration, typical of most higher vertebrates, whereby movements of the rib muscles cause lung ventilation.

buccal incubation (mouth brooding) In a number of species of fish, such as *Sarotherodon mossambicus* (cichlid), *Scleropages leichardti* (barramundi), of the family Osteoglossidae, and several sea-catfish (Ariidae), the male or the female carries the fertilized eggs in the mouth until some time after hatching. During incubation the parent involved takes no food, and so may appear rather lean at the end of the incubation period.

Bucconidae (puffbirds; order Piciformes) Family of small, black or brown and white birds with thick necks and large heads. The bill is stout with a hooked, often bifid, tip. There are rictal bristles, and the feet are zygodactylous. They are insectivorous and nest in holes in banks. There are 10 genera, with 32 species, found in tropical forests in C. and S. America.

buccopharynx The mouth and pharynx.

Bucerotidae (hornbills; order Coraciiformes) Family of medium to large, typically black and white birds with huge, curved, red or yellow bills, a casque on the culmen, short legs, and a long tail. They are arboreal and terrestrial. They nest in holes in trees, the females being walled in with mud. They are omnivorous, feeding mainly on fruit. There are 12 genera, with 46–49 species, found in Africa, S. Asia, Malaysia, the Philippines, Indonesia, and the Solomons. *See also* syndactylous.

Buchanania (family Anacardiaceae) Genus of trees, which are characteristic of regrowth forest, and yield useful timber. There are 25 species, occurring from India to Australia.

Buchan spells Several periods of the year, 'more or less well defined', when the normal seasonal rise or fall of temperature was halted or reversed for a

time, e.g. May 9–14 was a cold period and December 3–14 a warm period. They are named after the Scottish meteorologist Alexander Buchan, whose analysis of temperature records for Scottish stations in the middle of the nineteenth century revealed them. Six cold and three such warm periods were identified by Buchan in 1869. *See also* singularity.

buckbean (*Menyanthes*) *See* Menyanthaceae.

buckeye *See Aesculus*; and Hippocastanaceae.

buckler ferns *See Dryopteris*.

buckthorn (*Rhamnus catharticus*) *See* Rhamnaceae.

buckwheats *See* Polygonaceae.

buckwheat tree (*Cliftonia monophylla*) *See* Cyrillaceae.

bud Immature shoot, protected by tough scale leaves, from which the stem and leaves or flowers may develop.

budding 1 Formation of buds as a result of cell divisions in a localized area of a shoot. In general, budding is promoted by cytokinins and is inhibited by auxins. 2 Grafting of a bud on to a plant. 3 Gemmation, a form of asexual reproduction in which a new individual develops within the body wall or cell membrane of the parent, causing a bud-like swelling, then detaches itself to commence an independent life. In certain single-celled micro-organisms a new cell is formed by extrusion or outgrowth from an existing cell. *See also* asexual reproduction. 4 *See Monomorium pharaonis*.

Buddleja (family Loganiaceae) Genus of plants, many of which are ornamentals. They are rich in alkaloids. The flowers are clustered, attractive to butterflies, tetramerous, and have a superior ovary. Perhaps they are related to Scrophulariaceae. There are 100 species, occurring in the tropics and subtropics, and especially in E. Asia.

bud-fission Type of budding that occurs in certain types of fungi: the 'bud' or daughter cell is separated from the parent cell by a septum.

budgerigar *See Melopsittacus*.

buffalo Common name for several species of cattle-like mammals occuring in Africa south of the Sahara and in SE Asia. The N. American *Bison* is sometimes incorrectly called 'buffalo'. *See* Bovidae.

buffalo gnats *See* Simuliidae.

buffer Solution of a weak acid and its conjugate weak base that resists changes in pH that would otherwise result from the addition of an acid or base. The buffering properties of weak electrolytes in living organisms are of great importance, since most cells can survive only within narrow pH limits.

Bufo bufo (common toad, European toad; order Anura (Salientia), family Bufonidae) Species of toad in which the males are smaller than the females, and develop nuptial pads on three inner fingers in autumn for spring mating. Their colour is changeable, red-brown to grey. The species is native to Europe (including Great Britain), northern and temperate Asia, and N. Africa.

Bufo calamita (natterjack toad; order Anura (Salientia), family Bufonidae) Species of toad which is tolerant of brackish water. They have a prominent yellow dorsal stripe. The hind limbs are short, and the toads run rapidly but do not jump. The male has a large vocal sac. They grow up to 8 cm long. The species usually inhabits sandy soils in Britain and W. Europe.

Bufo marinus (marine toad; order Anura (Salientia), family Bufonidae) Species of toad comprising the largest bufonids, with females reaching 25 cm in length. The colour is mottled yellow-brown; there are red warts. Large parotid glands secrete a highly toxic poison. The species is a native of tropical America, but has been successfully introduced into Caribbean islands, Hawaii, Australia, and New Guinea.

Bufonidae (toads; class Amphibia, order Anura (Salientia), suborder Procoela) Squat-bodied amphibians which have short, powerful limbs for crawling. The skin is generally dry and warty. Teeth are absent. Vertebrae are procoelous, the pectoral girdle arciferal. A Bidder's organ (rudimentary ovary) is present in males. They are usually nocturnal or crepuscular land dwellers, only breeding in water. There are some 300 species, found in all continents except Australia and Antarctica.

Bufo viridis (green toad, changeable toad; order Anura (Salientia), family Bufonidae) Species of toads with a greyish body with green patches and red warts. It grows up to 9 cm long. It is tolerant of dry surroundings. It may breed in brackish water. The species occurs throughout much of S. and C. Europe, N. Africa, and W. Asia.

bugs *See* Hemiptera.

building phase Stage in the cyclical pattern of changes typical of grassland and heathland communities. In grassland, the term refers to the accumulation of wind-borne particles to form a small hummock around any grass seedling that chances to invade a hollow, which in turn results from the erosion of a former hummock in the degenerate phase. In heathlands, the term describes the bushy phase of growth in individual *Calluna vulgaris* (heather) plants, lasting from about 7–13 years of age. At this stage net primary production in the new shoots is at a maximum and the dense, bushy plant allows little light to reach the ground, hence it tends to suppress other species commonly associated with *C. vulgaris* in the pioneer, mature, and degenerate phases. *Compare* hollow phase; pioneer phase; mature phase; and degenerate phase; *see also* cyclical vegetation change; and mosaic.

bujedales *See* Mediterranean scrub.

bulb In plants, an underground storage organ, comprising a short, flattened stem with roots on its lower surface, and above it fleshy leaves or leaf bases, surrounded by protective scale leaves. It may provide the means for vegetative reproduction, or for the survival of the plant from one season to the next.

bulbil Any small, bulb-like structure, usually formed in a leaf axil, that separates from the parent plant and functions in vegetative reproduction.

Bulbine (family Liliaceae) Genus comprising two species of small, geophytic herbs found in Australia. They form tubers and have succulent, linear leaves and spikes of yellow, star-like flowers.

bulbuls *See Hypsipetes*; Pycnonotidae; and *Pycnonotus*.

Bulgaria (order Helotiales) Genus of fungi that form gelatinous apothecia within which the unicellular brown and/or colourless ascospores are produced. *B. inquinans* ('Pope's buttons') is a common species, with black, globular to cup-shaped, rubbery fruit bodies, each 2–4 cm across, which grow in clusters on logs, especially those of oak.

bulk density Mass per unit volume of soil (sampled as a clod or core), dried to constant weight at 105 °C.

bulla In most mammals, a thin-walled, bony projection of the skull, often hemispherical, which encases the middle ear.

bullate Bearing blister-like swellings; blister-like in appearance.

bulldog ant *See* Myrmeciinae.

bulldog bat (*Noctilio*) *See* Noctilionidae.

bullfinches *See Pyrrhula*.

bullfrog (American) *See Rana catesbiana*.

bullhead shark *See* Heterodontidae.

bullock's heart (*Annona reticulata*) *See Annona*.

Bullomorpha *See* Cephalaspidea.

bullseye *See* Pempheridae; and Priacanthidae.

bulrush (*Scirpus lacustris*) *See Scirpus*; and Typhaceae.

bumblebee Any member of the genus *Bombus* (family Apidae).

bumpiness Unevenness experienced in the flight of an aircraft caused by convection or turbulence in conditions of atmospheric instability or over orographic barriers. *See also* clear-air turbulence.

Bungarus (kraits; order Squamata, suborder Serpentes (Ophidia), family Elapidae) Genus of venomous snakes which are nocturnal, and grow up to 2 m long. They feed almost exclusively on other snakes, and occur in SE Asia.

bunodont Applied to teeth in which the cusps are rounded.

bunt (stinking smut) Disease of wheat caused by the smut fungus *Tilletia caries*. The grain in an infected ear of wheat is replaced by masses of fungal spores which have a characteristic fishy smell; the spores are released when the wheat crop is harvested.

buntings *See Calcarius; Emberiza*; Emberizidae; and *Passerina*.

bunya bunya *See Araucaria*.

buoyancy Condition arising from the difference between the density of a given parcel of air or gas and that of the surrounding air. It is this that makes a hydrogen- or helium-filled balloon or airship float or rise through the atmosphere. Also, if an air parcel is warmer than its surroundings, the density difference implies an upwards-directed force acting upon that parcel of air and it will rise, with positive buoyancy. When a parcel of air is colder than its surroundings the reverse condition causes it to sink, with downward (negative) buoyancy. *See* thermal.

Buprestidae (jewel beetles; class Insecta, order Coleoptera) The most beautiful of beetle families, often used in jewellery. The more spectacular species are tropical; in Britain they emerge occasionally from imported timber. The elytra and thorax are elongate, with bright metallic colours; they are often of a considerable size. The eyes are large, the antennae short and filiform. The Buprestidae are daytime nectar feeders. The larvae are club-shaped, legless, and called 'flat-headed borers'; the head is tiny, the prothorax unusually broad, the body narrow and tapering. The larvae live in trees or roots, where they gnaw flattened tunnels. Some mine leaves or stems. There are 11 500 species.

buran Regional wind in Russia and central Asia which blows strongly from the NE in both winter and summer. In winter it is very cold and is associated with much snow, when the wind is also termed 'purga'.

burbot (*Lota lota*) *See* Gadidae.

Burchell's quagga (*Equus burchelli*) *See Equus*; and zebra.

Burckella (family Sapotaceae) Genus of 11 species of timber trees of lowland rain forest, occurring from the Moluccas to the W. Pacific islands.

Burdigalian Stage of the early Miocene underlain by the Aquitanian and overlain by the Langhian. Dated radiometrically as beginning 22.5 million years ago and ending 7 million years later. Mammals, including elephants, are important in the stratigraphic definition of this stage.

Burhinidae (thick-knees, stone-curlews; order Charadriiformes) Family of sandy or grey-brown birds with large heads and eyes, shortish, stout bills, and long legs with thickened tibiotarsal joints. The feet are semipalmate with three toes. They are crepuscular and nocturnal, in open, stony and sandy country. They feed on invertebrates, mice and frogs, and are ground-nesting. There are two genera, with nine species, found in Africa, Europe, Asia, Australia, C. and S. America.

buried soil Soil covered by an alluvial, colluvial, aeolian, glacial, or organic deposit, and being a product of a former period of pedogenesis. In US usage a buried soil is defined as lying beneath 30–50 cm if the covering layer is more than half the thickness of the buried soil, otherwise beneath more than 50 cm.

Burkitt's lymphoma Tumour of lymphoid tissue which appears to be caused by the Epstein–Barr

virus. Burkitt's lymphoma occurs chiefly in parts of Africa and affects mainly children.

Burma cedar *See Toona*.

Burmannia *See* Burmanniaceae.

Burmanniaceae Family of mostly small and saprotrophic, colourless herbs, in which leaves are often absent. The flowers are trimerous, the fruit a capsule. Principal genera are *Burmannia* and *Thismia*. The family is closely related to Orchidaceae. There are 5–16 genera, with 125 species.

Burma tulipwood *See Dalbergia*.

burnet 1 *See Sanguisorba*. 2 *See Poterium*. 3 (entomol.) *See* Zygaenidae.

burrowing goby *See* Trypauchenidae.

Bursaria (family Pittosporaceae, tribe Pittosporeae) Genus of thorny shrubs. They have cream or white, scented flowers in dense terminal panicles, and the fruit is a capsule. There are three species endemic to Australia.

Bursaria spinosa (blackthorn) Plant that is widespread in Australia and often regarded as a weed. *See Bursaria*.

Burseraceae Important family of resiniferous, tropical timber trees, in which the leaves are pinnate, with stipules. The flowers are unisexual and small, their parts usually in threes or fives, with a disc. The fruit is a drupe or capsule. There are 16 genera, with 500 species.

'burst of monsoon' Applied to the onset of a marked change in weather conditions in the Indian subcontinent and SE Asia, associated with the arrival of humid SW winds which displace the hot, dry, pre-monsoon regime. The changed surface-level wind pattern is related to the establishment of a high-level easterly jet stream.

burying beetle *See* Silphidae.

bushbaby (*Galago*) *See* Lorisidae.

bush cricket *See* Gryllidae.

bush dog (*Speothos venaticus*) *See* Canidae.

bush katydid *See* Tettigoniidae.

bush larks *See Mirafra*.

bush rat *See* Octodontidae.

bush-shrikes *See Tchagra*.

bushtits (*Psaltriparus*) *See* Aegithalidae.

bush warblers *See Cettia*.

bustards *See Eupodotis*; and Otidae.

butcherbirds *See* Cracticidae.

Buteo (buzzards, hawks; family Accipitridae) Genus of mainly brown, broad-winged, broad-tailed, medium-sized birds, which are well adapted to soaring. The toes are short and thick, the tarsi sometimes feathered to the toes. They are found in open country and forests, and are mainly migratory. They feed on mammals and reptiles. They are mainly tree-nesting, but some nest on crags or on the ground. There are 25 species, found in the Americas, Europe, Asia, and Africa.

butt The base of a tree, or lower end of a log.

butte Small, isolated, flat-topped hill resulting from the erosion of near-horizontal strata. The diameter of the caprock is less than the height of the landform above the surrounding country. Buttes are commonly found in semi-arid regions dominated by duricrust horizons. *See also* mesa.

butterfish *See* Pholididae; Scatophagidae; and Stromateidae.

butterflies *See* Lepidoptera.

butterfly cichlid (*Apistogramma ramirezi*) *See* Cichlidae.

butterfly fish *See* Chaetodontidae; Osteoglossiformes; and Pantodontidae.

butternut (*Juglans cinerea*) *See Juglans*.

butterwort *See Pinguicula*; and Lentibulariaceae.

buttonquails *See* Turnicidae.

Butyrospermum (family Sapotaceae) Genus of which *B. parkii* is the only species. It is a tropical African plant whose seeds yield shea-butter when pressed.

butyrous Like butter in consistency.

Buxaceae Family of evergreen shrubs or trees whose leaves are without stipules. The flowers are small and regular, with two or three sepals and petals, 4–6 free anthers, and a superior ovary of three fused carpels. The fruit is a drupe or capsule. The seeds are black and shiny, sometimes with a caruncle. The family is related to the Euphorbiaceae. There are six genera, with about 100 species, occurring in temperate and tropical regions.

Buxbaumiales (subclass Bryidae) Order of small, sometimes minute, acrocarpous mosses. The leaves and shoots are often poorly developed, and the capsule is disproportionately large; in some species there are no leaves and the branched, filamentous protonema is persistent. They are found on acid soil on moorlands and in woods, and on soil-covered rocks in mountainous regions. (This characteristic group of mosses is sometimes elevated to subclass level: Buxbaumiideae.)

Buxbaumiideae *See* Buxbaumiales.

Buxus (family Buxaceae) Widespread genus of trees. *B. sempervirens* (box) has a valuable, very close-grained wood. There are 70 species.

Buys Ballot's law Law, enunciated by C. H. D. Buys Ballot of Utrecht in 1857, that in the northern hemisphere the winds blow anticlockwise around centres of low pressure and clockwise around areas of high pressure. In the southern hemisphere both these tendencies are reversed.

buzzards 1 *See* Accipitridae; and *Buteo*. 2 (honey buzzards) *See Pernis*.

Byblidaceae Group of plants that formerly was regarded as a separate family, but whose genera are now placed within the Droseraceae.

Byblis (family Droseraceae) Genus of carnivorous herbs. Their stems and leaves have glandular hairs

and exude a sticky substance which attracts and attaches insects. The flowers are five-petalled and usually purple. There are two species, endemic to Australia.

Byrrhidae (pill beetles; class Insecta, order Coleoptera) Family of dull, pubescent, highly convex beetles, 1.5–10 mm long. The antennae are clubbed. When disturbed, the legs are withdrawn completely into grooves on the underside of the abdomen. *Byrrhus pilula*, the most common British species, is found under stones, and in grass. Larvae are fat and cylindrical, with a large, broad prothorax, and a pair of retractable false legs on the terminal segment. Larvae are found among roots and in moss. There are 270 species.

Byrrhus pilula (pill beetle) *See* Byrrhidae.

byssate Applied to the condition found in certain pelecypods of being attached to the substrate or to objects by strands of byssus (usually tough, horny threads).

Byssochlamys (family Eurotiaceae) Genus of fungi that are found chiefly in soil. *B. fulva* can cause spoilage of canned or bottled fruit. Its ascospores can survive heating to a temperature of 84–87 °C.

byssoid Consisting of fine threads.

byssus *See* byssate.

bytownite Mineral, specific gravity 2.7, hardness 6.0–6.5, and with the chemical composition $25Na(AlSi_3O_8)75Ca(Al_2Si_2O_8)$. It is a member of the plagioclase group of feldspars, and is a basic feldspar found mainly in basic igneous rocks, e.g. gabbro, basalts, and norites. It is normally grey-white, and often tinged with darker colours, e.g. blue and red; and has a vitreous lustre. It crystallizes in the triclinic system. Crystals are often tabular prismatic, but normally they form irregular grains. It is a rock-forming mineral.

Byttneriaceae Group of plants that formerly was regarded as a separate family, but whose genera are now placed within the Sterculiaceae.

C

C See carbon.

^{14}C *See* radiometric dating.

C3 pathway The most common pathway of carbon fixation in plants. *See also* photosynthesis, photorespiration.

C4 pathway Pathway of carbon fixation, found most commonly in tropical plants that have high rates of growth and photosynthesis and that are adapted to high temperatures, strong light and low water supply. Its importance seems to be as a mechanism for concentrating CO_2 without having to open the stomata fully during the day. The first product formed as a result of the carboxylation by CO_2 of an acceptor molecule, phospho-enolpyruvate (PEP), is the four-carbon oxaloacetate (OAA). Eventually the CO_2 is handed on to, and refixed by, the Calvin cycle.

Ca *See* calcium.

caatingas Thorn forest of NE Brazil and similar or allied types of vegetation including thornwoods and thornbush. They are differentiated from savannah woodlands by the paucity or absence of grass, which reflects a more prolonged dry period and smaller total amounts of rainfall.

cabbage *See Brassica*.

cabbage white butterfly *See Pieris brassicae*.

Cactaceae The cactus family, comprising plants with succulent stems, bearing tufts of spines, and with the leaves reduced or absent (except *Pereskia*). Flowers are solitary, sessile, showy, and hermaphrodite, with many parts, and the ovary inferior. The fruit is a juicy or leathery berry with many seeds. The family has no close relatives. A few cactuses are epiphytes. There are 87 genera, with more than 2000 species, occurring in the semideserts of America (with *Rhipsalis* in Madagascar and Sri Lanka).

caducous (bot. and zool.) Soon dropping off.

caecilians (class Amphibia, order Apoda (Gymnophiona)) Burrowing, worm-like amphibians which have no limbs or limb girdles, eyes that are rudimentary, vestigial hearing apparatus, a sensory feeler beneath the eye, no gills or gill slits in adult, and a tail that is small or absent. Dermal scales occur in the skin of some species. Fertilization is internal, as a cloacal copulatory organ is developed in the male. Distribution is tropical and subtropical. *See also* Typhlonectidae; Caecilidae; and Ichthyophiidae.

Caecilidae (caecilids; class Amphibia, order Apoda (Gymnophiona) Family of caecilians that are mainly terrestrial as adults. Development is oviparous or ovoviviparous, often with a free-swimming larval stage. Stapes are present. The tail is absent. There are more than 100 species, in localized populations in the Old and New World tropics.

Caelifera (class Insecta, order Orthoptera) Suborder that includes the families Acrididae, Cylindrachetidae, Eumastacidae, Pneumoridae, Proscopiidae, Pyrgomorphidae, Tetrigidae, and Tridactylidae. The antennae have fewer than 30 segments. The auditory organs, when present, are found on the sides of the first abdominal segment, and stridulation is usually produced by friction between the hind femora and either modified lateral veins on the forewing, or areas on the abdomen. The ovipositor, when present, is short, and consists of four separate valves.

Caenogastropoda (phylum Mollusca, class Gastropoda) Combination of the orders Mesogastropoda and Neogastropoda.

Caenolestidae *See* Caenolestoidea.

Caenolestoidea (opossum rats; infraclass Metatheria, order Marsupialia) Superfamily comprising a single family (Caenolestidae) of shrew-like marsupials, known since the Eocene. Opossum rats possess four upper and three or four lower incisors, the first lower pair being large. The hind feet are didactylous (second and third digits not united in a single sheath); the first hind digit has a claw. There is no marsupium. Opossum rats live in the Andes forests. There are seven species in three genera: *Caenolestes*; *Lestoros*; and *Rhyncholestes*.

Caesalpinia (family Leguminosae, subfamily Caesalpinoideae) Genus of 100 species of tropical plants, many of them woody climbers. Wood of *C. sappan* yields a red dye (sappan or brazilwood).

Caesalpinoideae One of the three subfamilies of the Leguminosae, comprising 180 genera of mainly tropical and woody plants, including many climbers. Leaves are usually pinnate with stipules. Flowers are more or less zygomorphic, with free sepals and petals, and are usually imbricate, the uppermost petal innermost in the bud; usually they have ten or fewer stamens.

Caesar's mushroom Common name for the mushroom-shaped, orange fruit body of *Amanita caesarea*, which is edible and highly esteemed. It is found on the ground under broad-leaved trees, and occurs in parts of Europe (not Britain), and in the Americas.

Caesia (family Liliaceae) Genus of small plants with strap-like leaves and clusters of white or pale mauve, six-petalled flowers. There are representatives in S. Africa, Australia, and New Guinea. Six species are endemic to Australia.

caespitose Growing in dense tufts.

caiman *See* Alligatoridae.

Caiman crocodilus (spectacled caiman; order Crocodilia, family Alligatoridae) Species of crocodilian whose common name is derived from the large, bony ridge between the eyes. The belly has large, overlapping, bony scutes. *C. crocodilus* feeds in the water on fish, water birds, and mammals that come down to drink; and occurs in C. and tropical S. America.

Cainotheriidae Small artiodactyls from the late Eocene and Oligocene of Europe. They lacked gnawing front teeth, but otherwise seem to have resembled hares and rabbits. Their hind legs were markedly elongated, implying a hopping gait. They became extinct in the Miocene, apparently displaced by early members of the true Lagomorpha.

Cainozoic *See* Cenozoic.

cairngorm *See* quartz.

Cajanus (family Leguminosae, subfamily Papilionatae) Genus of two species of tropical African plants. *C. cajan* is the pigeon pea, a perennial shrub, the whole plant being useful as a cover crop and the seed for dhal.

cajeput oil *See Melaleuca*.

Calabrian Early Pleistocene stage which began 1.8 million years ago. It lasted 1.3 million years and is noted for major evolutionary changes in mammalian faunas.

Caladenia (family Orchidaceae) Genus of ground orchids with a small, narrow leaf, produced annually. The flowers are borne on a single stem and are very variable in size. There are 70 species, found in Australia and New Zealand in temperate and cold-temperate areas.

calamine 1 Mineral, specific gravity 3.4–3.5, hardness 4.0–5.0, and with the chemical composition $Zn_4(Si_2O_7)(OH)_2.H_2O$. It occurs in the oxidation zone of lead-sulphide/zinc-sulphide deposits, in hydrothermal veins near the surface, and as a primary mineral in hydrothermal veins, associated with sulphides and fluorite. Its colour, when massive, can be white, grey, yellow, brown, green, or light blue, and sometimes it is colourless; it has a vitreous lustre. It crystallizes in the orthorhombic system. The crystals can be small, tabular grains, but normally they are aggregates of radial or earthy masses. It is an ore mineral for zinc. 2 *See* smithsonite.

calamistrum *See* cribellum.

Calamites cistiiformes Jointed-stemmed calamitids were an important component of Carboniferous swampland floras. Unlike their small modern counterparts some Carboniferous species grew to 18 m tall. *Calamites cistiiformes* was the first representative of the family Calamitaceae. It was first described by Stur in 1877; calamatids are known throughout the northern hemisphere.

Calamoichthys (reedfish) *See* Brachiopterygii.

Calamus (family Palmae) Genus of palms in which the stem is clothed in a spiny tubular sheath, 10 m or more long, and flexuous, rarely short and erect. Leaves are pinnate, often with a long, protruding, spiny tip (cirrus), or with modified, sterile, spiny inflorescences (flagella), rarely both; the spiny whips grapple the surrounding forest. *Calamus* is dioecious. The inflorescence has tubular, spiny sheaths. Fruits are scaly, often with a thin, sour pulp. Many species produce useful cane, a few entering international commerce. *Calamus* is the largest of all palm genera, and the most wide-ranging genus of climbing palms (rattans or rotans). There are about 370 species, in Africa, India, and S. China, south through the Malay archipelago to N. Australia, and from the W. Pacific islands to Fiji.

Calandrella (larks; family Alaudidae) Genus of brown, small-billed larks with plumage well adapted to their habitats of grassy plains and semi-desert. They feed on insects and seeds, and are ground-nesting. There are 12 species, found in Europe, Africa, and Asia.

Calandrinia (parakeela; family Portulaceae) Genus of small, annual, or biennial herbs with pink flowers. They are represented in western N. America, S. America, and Australia. There are approximately 30 species endemic to Australia and found mainly in arid areas around salt lakes.

calcaneum *See* fibulare.

calcar In Chiroptera, a process of the fibulare that helps to support the uropatagium.

Calcarea (Calcispongea; phylum Porifera) Class of marine sponges which possess a skeleton of calcareous spicules. Forms displaying leucon structure are common, and sycon and ascon forms also occur. Individuals vary in shape from tube colonies to massive forms. They first appeared in the Cambrian.

calcarenite Calcareous sediment in which a high percentage of the clasts can be of quartz within a calcareous matrix or, more generally, a clastic limestone in which both clasts and matrix are calcareous. Calcarenites are characterized by a particle range of 0.006–2.00 mm in diameter.

calcareous ooze Deep-sea, fine-grained, pelagic deposit containing more than 30% calcium carbonate. The calcium carbonate is derived from the skeletal material of various planktonic animals and plants, e.g. foraminiferan tests and coccoliths (which are calcitic), and pteropod tests (which are aragonitic). Calcareous ooze is the most extensive deposit on the ocean floor but is restricted to water depths less than about 3500 m. *See also* carbonate-compensation depth.

calcareous soil Soil that contains enough free calcium carbonate to effervesce visibly, releasing carbon-dioxide gas, when treated with cold 0.1 *N* hydrochloric acid, and which could also be regarded as a basic or alkaline soil.

Calcarius (buntings, longspurs; family Emberizidae) Genus of small brown birds, the males patterned with black and white, and with tails edged with white. They are found in plains, prairies, and tundra, and are seed-eating and ground-nesting. There are four species, found in N. America and N. Eurasia.

Calcaronea (phylum Porifera, class Calcarea) Subclass of sponges whose larvae have an area of flagellate cells equal to the area of non-flagellate cells. The flagellum emanates from the nucleus of the cell.

calcic *See* calcification.

calcic horizon Mineral soil horizon with evidence of secondary calcium-carbonate deposition which is more than 15 cm thick, with a calcium-carbonate content of more than 15% by weight, and with 5% carbonate more than is in the parent material or horizons below it.

calcicole Plant species confined to, or most frequently found on, soils containing free calcium carbonate. *Compare* calcifuge.

calcicolous Applied to an organism that prefers to grow in, or can grow only in, habitats rich in calcium ('lime').

calciferol Compound designated vitamin D_2, obtained through the ultraviolet irradiation of ergosterol. *See also* vitamin D.

calcification Process of redeposition of secondary calcium carbonate, from other parts of the soil profile, which if sufficiently concentrated may develop into a calcrete, caliche, kunkar, or calcic horizon (all similar and usually comprising more than 15% weight of calcium carbonate in more than 15 cm soil thickness). Calcification involves limited upward and lateral movement of calcium salts in solution, and downward movement in less wet periods. When occasionally leaching is deeper, some but not all of it may redissolve.

calcifuge Plant species not usually found on soils containing free calcium carbonate. *Compare* calcicole.

Calcinea (phylum Porifera, class Calcarea) Subclass of sponges whose larvae have only a very small area lacking flagellate cells. The flagellum is independent of the cell nucleus.

Calcispongea *See* Calcarea.

calcite Very common and widespread, rock-forming mineral, specific gravity 2.7, hardness 3.0, chemical composition $CaCO_3$. It is a major constituent of calcareous sedimentary rocks, e.g. limestones, marbles, and chalks, and which can be precipitated from sea-water. It is distinguished by its perfect rhombohedral cleavage, its hardness, and its solubility in dilute hydrochloric acid. It is usually colourless or white, but may be shades of yellow, grey, green, red, or even brown or black; it has a white streak, and a vitreous lustre. It crystallizes in the trigonal system. Crystals are common, often tabular, prismatic, or rhombohedral in shape, but fibrous aggregates and granular masses may also occur. The cleavage rhombs exhibit double refraction. It is used as a flux; in cement making and fertilizers; and as a building stone. *See also* carbonates.

calcium An element (symbol Ca) that is necessary for plant growth. In eukaryotic cells it is found mainly in the apoplasm where it preserves membrane integrity and strengthens cell walls. It protects roots against the effects of low pH, ion imbalance, and toxic ions, so that reduced root growth is a symptom of deficiency, as is 'die back' of buds.

calcrete *See* caliche.

caldera Large volcanic depression, varying in diameter from about 1 to 250 km, that has been enlarged through erosion, subsidence, or violent explosion. Generally three varieties are recognized: the collapse caldera, e.g. Crater Lake, Oregon, resulting from explosive activity followed by collapse; the explosion caldera, e.g. Bandai San, Japan; and the erosion caldera, e.g. Papenoo, Tahiti.

Caledonian orogeny Major mountain-building episode which took place during the Lower Palaeozoic Era. The orogeny affected Greenland, Ireland, Scotland, and Scandinavia, and was associated with the closure of the Iapetus Ocean between the Canadian and Baltic Shields.

caliche Carbonate horizon (the K horizon) formed in a soil in a semi-arid region, normally by the precipitation of calcium carbonate carried in solution. It may become cemented and indurated on exposure, when it gives rise to a tabular landscape. *See also* calcic; duricrust; duripan; and petrocalcic.

Caliciaceae (order Caliciales) Family of lichens in which the thallus is crustose or squamulose; the asci are thin-walled and soon disintegrate, forming a mazaedium. Spores are brown or colourless. There are many genera. Usually they are found on bark or wood.

Caliciales (subdivision Ascomycotina) Order of lichens in which the thallus is crustose, squamulose, foliose, or fruticose. The apothecia are typically stalked, and their contents typically fragment to form a mazaedium. There are four families. They are found chiefly on wood or bark, occasionally on rocks; there are a few parasitic species.

Calidris (sandpipers, stints; family Scolopacidae) Genus of small to medium-sized waders which have bills of moderate length. *C. alba* (sanderling) lacks a hind toe. They breed in tundra and upland regions, where they are ground-nesting. In winter they are found on shores and estuaries: they are highly migratory. There are 18 species, found worldwide.

Calidris alba (sanderling) *See Calidris*.

California condor (*Gymnogyps californianus*) *See* Cathartidae.

California current Southward-flowing, eastern boundary current carrying cool water from the West Wind Drift to join the North Equatorial current. This slow-moving, diffuse water mass flows down the west coast of N. America.

California grunion (*Leuresthes tenuis*) *See* Atherinidae.

California halibut (*Paralichthys californicus*) *See* Bothidae.

Callaeas *See* Callaeidae.

Callaeidae (wattlebirds; order Passeriformes) Family of medium-sized brown and black or grey birds, with paired fleshy wattles at the corners of their mouths, revealed when at full gape. They have rounded wings, long first primaries, and long tails, and are arboreal and tree-nesting. They feed on insects and fruit. Two monotypic genera, *Callaeas* and *Creadion*, are both found in New Zealand. A third species, *Heteralocha acutirostris* (huia), noted for extreme sexual differentiation of the bill, is now extinct.

Callanthidium *See* Megachilidae.

Callichthyidae (armoured catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of small, bottom-dwelling, freshwater fish. The body is covered with tile-like scales, the head shows a rather steep profile with the ventrally-positioned mouth surrounded by barbels. Several species, when exposed to oxygen-deficient water, can gulp in air and store it in the gut. There are about 130 species, a number of them being well known to aquarium hobbyists, e.g. the bronze catfish (*Corydoras aeneus*) and the pygmy catfish (*C. hastatus*). They occur in the tropical rivers of S. America.

Callicoma (family Cunoniaceae) Monotypic genus of plants. *C. serratifolia* (black wattle) is a tree up to 6 m high. It has cream flowers in clusters similar to those of wattle (*Acacia*) but is unrelated to this. It is endemic to Australia and is found in shaded gullies of New South Wales and Queensland.

calling hare (*Ochotona*) *See* Ochotonidae.

Callionymidae (dragonets; class Osteichthyes, subclass Actinopterygii, order Gobiesociformes) Family of marine, warm-water fish. Mainly shallow-water bottom-dwellers, they have somewhat flattened bodies, a small mouth, and narrow gill openings on the upper side of the head. The males are often brightly coloured and have larger fins than the females. The male of the European dragonet (*Callionymus lyra*) reaching a length of about 30 cm, is known to initiate a 'nuptial dance' prior to spawning. There are about 40 species, some of them found at depths of several hundred metres. A number of authors consider the dragonets to belong to the order Perciformes.

Callionymus lyra (European dragonet) *See* Callionymidae.

Calliphora vomitoria (blow fly; bluebottle; order Diptera, suborder Cyclorrapha, family Calliphoridae) The familiar bluebottle, which occurs in houses, and in which the male may be recognized by its chequered, blue-metallic abdomen, with long, plumose arista. Males have eyes that are almost holoptic. The name 'blow fly' refers to their habit of laying eggs on exposed meat, which is then known as 'blown', and is unfit for human consumption. The eggs are laid on or near the chosen larval food, usually carrion or decaying animal matter. The larvae ('gentles') are cream in colour, cylindrical, and legless, and are much used as bait by anglers. They feed by liquefying the food, several often working in unison. The pupae are typical of cyclorraphous flies, being inside the last instar larval cuticle, now tanned as the puparium. Adults feed by exuding a fluid from a trumpet-shaped proboscis and dissolving food materials which are then imbibed. The feeding habits of the adult, and the larval habitat, make these flies potential vectors of disease.

Calliphoridae (bluebottles, greenbottles, blow flies; class Insecta, order Diptera, suborder Cyclorrapha) Large family of medium-sized to large flies whose larvae are saprophagous, or flesh-feeders. As a group the family can be distinguished from the similar Muscidae by the possession of hypopleural and pteropleural bristles. The post-scutellum is well developed, and the second abdominal sternite is overlapped by the tergite. The family includes the major subfamilies of Sarcophaginae and Calliphorinae. Larvae of Sarcophaginae occur in decaying animal or plant tissue, or may be parasitic on insects or other animals. Calliphorinae are often metallic blue or green, with a markedly plumose arista, and many species are important as pests, disease-carriers, or blood-suckers. The larvae of *Lucilia sericata* (greenbottle) bore into the flesh of sheep and can cause death if present in large numbers. *Cochliomyia hominvorax* (screw-worm fly) is a serious pest of cattle in N. and S. America, and has recently been eradicated from most of the USA by a costly programme of sterile-male release. Other species can attack humans and cause lesions or myiasis. More than 1000 species are known.

Calliphorinae *See* Calliphoridae.

Callistemon (family Myrtaceae) Genus of plants in which the inflorescences are conspicuous, stout spikes, beyond which a leafy shoot extends. Several species are ornamentals. There are 25 species, occurring in Australia and New Caledonia.

Callitrichaceae Family of aquatic plants in which the stems are filiform, leaves in opposite pairs, entire, and exstipulate. The flowers are tiny, monoecious, borne in leaf axils, and without a perianth. There is one stamen; the ovary is four-celled and four-lobed; there are two long styles; and the fruit consists of four tiny drupes. There is one genus, *Callitriche*, with about 30 species, of cosmopolitan distribution.

Callitrichidae (marmosets, tamarins; order Primates, suborder Anthropoidea, superfamily Ceboidea) Family of very small, squirrel-like, insectivorous and fruit-eating, New World monkeys. They have thick fur, non-prehensile tails, claws on all but the first hind digits, and a quadrupedal gait. There are only two molar teeth, except in the genus *Callimico*, and no cheek pouches. The nostrils are well separated and lateral-facing (platyrrhine). The thumb is not opposable. Litters commonly consist of two or three young, and the placental yolk sac grows larger than in most higher primates. The Callitrichidae live in family groups of three to eight individuals, but sometimes in larger groups. Fully arboreal, they inhabit the forests of tropical S. America. There are five genera, with 33 species.

Callorhynchidae (elephant fish, plownose chimaera; class Chondrichthyes, subclass Holocephali,

order Chimaeriformes) Small family of marine fish belonging to the subclass Holocephali and related distantly to the sharks and rays. They possess a cartilaginous skeleton and the club-shaped body terminates in a flexible process above the mouth resembling the trunk of an elephant, especially in the males. Unlike sharks, the elephant fish have a movable gill cover over the gill openings, and no spiracle. The males possess copulatory claspers on the ventral fins and the females produce eggs that are protected by a horny case. Fertilization is internal. The few species known are found in the southern hemisphere.

callose Insoluble glucan found in higher plants, in which glycosidic linkages join the first and third carbon atoms of neighbouring beta-glucose units. Structurally it is similar to the protozoal storage carbohydrates, paramylon and leucosin, and also to the algal product laminarin. In Angiospermae it is formed in response to injury, especially in phloem and in germinating pollen tubes.

Calluna (family Ericaceae) Monotypic genus of low, evergreen shrubs with tiny, adpressed, opposite leaves, and flowers borne in the axils of upper leaves. The flowers are tetramerous; the calyx is coloured like the corolla, but is larger and more deeply lobed. There are eight stamens. The fruit is a capsule. *Calluna* dominates large areas of heathland on acid soils in W. Europe, forming the community known as Callunetum. The genus is confined to Europe, the Azores, and N. Africa.

Callunetum *See Calluna*; and -etum.

callus In plants, tissue that forms over a wound.

calm Condition of general lack of wind, indicated by a wind speed of less than 1 knot (0.5 m/s). *See also* Beaufort scale.

Calocera (family Dacrymycetaceae) Genus of fungi which form upright, cylindrical or tapering, branched or unbranched, orange or yellow fruit bodies. They are found on tree-stumps, logs, etc., in woodland; *C. viscosa* grows on softwood, while *C. cornea* is common on hardwood.

Calophyllum (family Guttiferae) Genus of tropical timber trees, in which the bark surface is usually fissured, releasing coloured, sticky latex. The fruit is a drupe, the stone often opening by a plug. There are more than 100 species, occurring mainly in Malesia, with a few in Africa, Madagascar, and the New World.

Caloplaca (family Teloschistaceae) Genus of lichens in which the thallus is crustose, sometimes with radiating lobes, and is frequently bright yellow or orange. The apothecia are typically yellow, orange, or rust-coloured. Spores are colourless, and generally have a thick wall across the middle which is perforated by a narrow canal. There are numerous species, found on a range of substrates, including rocks, bark, etc.

Calopterygidae (Agriidae, damselflies; order Odonata, suborder Zygoptera) Fairly ubiquitous family of damselflies which have complex courtships. They have indistinguishable primaries among their many antenodal wing veins. Many species have metallic-coloured bodies, and heavily tinted wings. The nymphs are usually found in fast-flowing streams, and are of slender build. More than 180 extant species have been described. *See also* venation.

Calopteryx virgo (demoiselle; family Calopterygidae) Beautiful damselfly which is commonly seen flying with a characteristic flutter near fast-running, clear streams. Males have striking, blue-violet wings; females have amber-brown wings; and both sexes have metallic-coloured bodies. The species occurs throughout Europe and N. Asia.

calorific value The gross calorific value of a substance is the number of heat units that are liberated when a unit weight of that substance is burned in oxygen, and the residual materials are oxygen, carbon dioxide, sulphur dioxide, nitrogen, water, and ash. The energy content of biological materials has been expressed traditionally in calories (cal.) or kilocalories (Cal.) per gram dry weight. Sometimes results are expressed more significantly in terms of ash-free dry weight, i.e. in terms of organic constituents only. Contemporary studies of ecological energetics express results in terms of the SI energy unit, the joule (4.182 J = 1 calorie).

Calospatha (family Palmae) Genus of climbing palms (rattans), in which the stem is solitary, and robust to a height of 10 m, with no grappling whips. The plant is dioecious, the inflorescence being short, with persistent, successively smaller, overlapping bracts. The fruits are scaly, and contain three seeds embedded in a thin sheet of edible pulp (sarcotesta). The cane is not used. There is one species, endemic to Malaya, where it is very local and was overlooked for 50 years.

Calotes versicolor (bloodsucker, Indian variable lizard; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Species of slender, agile, long-tailed, tree lizards, up to 49 cm long. The males are remarkable for changing colour from brown to yellow and then to blood-red in rapid succession during courtship contests. The species is widely distributed from Iran to S. China and Sumatra.

Calothrix (order Nostocales) Genus of filamentous cyanobacteria in which the filaments are attached to a substrate at their bases only, typically occurring in felt-like tufts. They are found growing on rocks in freshwater and marine environments.

Calvatia (order Lycoperdales) Genus of fungi that includes the giant puffball *Calvatia gigantea* (also known as *Lycoperdon giganteum* or *Langermannia gigantea*). Fruit bodies of this species are usually 30–50 cm across, but specimens measuring up to 1.5 m across have been recorded. The colour is initially white, becoming yellowish to brown. The flesh is white, becoming olive-brown and powdery as spores develop. It is found in grassland, woods, gardens, etc., and is edible when young.

Calvin cycle Cyclic series of reactions occurring in the stroma of chloroplasts, in which carbon dioxide

is fixed and reduced to glucose using ATP and NADPH formed in the light reaction of photosynthesis. The first product formed is a three-carbon sugar.

calving (geomorph.) Process whereby portions of a glacier's leading edge break off as icebergs into an adjacent body of water.

calvus From the Latin *calvus* meaning 'bald' or 'stripped'; a species of cumulonimbus cloud in which upper protrusions form a more amorphous mass than appears from the cumuliform outlines. *See also* cloud classification.

Calycanthaceae Small family of trees and shrubs, most of them aromatic, with simple, opposite, exstipulate leaves, and flowers which have numerous tepals, stamens, and free carpels, the carpels and achenes lying within the hollowed receptacle. There are three genera, with eight species, occurring in E. Asia (*Chimonanthus*), N. Queensland (*Idiospermum*), and N. America (*Calycanthus*).

calyciform Shaped like a calyx or cup.

Calycophorina (order Siphonophora) Suborder of Cnidaria: individual members lack a float, but at its top each colony of them has one or more large swimming bells (nectophores), attached to widely separate groups of zooids. There are four extant families.

Calyptoblastina (Leptomedusae, Thecata; order Hydroida) Suborder of Cnidaria in which the colony is covered by a chitinous perisarc with cup-like extensions, the hydrothecae and gonothecae, which protect the feeding and reproductive polyps respectively. Medusae have gonads on the radial canals.

Calyptoptomatida (phylum Mollusca) Extinct Palaeozoic class of marine molluscs, with bilateral symmetry, in which the shell shape is variable: most are subtrigonal in cross-section. The walls are generally thick, and composed of laminated calcium carbonate. The apertural end is the widest; the narrowest is the closed apex, which may be pointed or blunt. The juvenile portion is chambered with imperforate septa. Externally the shells are smooth, or ornamented with growth lines and/or longitudinal and transverse ridges. The aperture is usually protected by an operculum possessing paired muscle scars. Individuals are 1–150 mm long. The class ranges in age from Lower Cambrian to Middle Permian, and contains two orders.

calyptra Protective cap- or hood-like covering on the developing capsule in a moss or liverwort. In mosses the calyptra usually remains until the capsule is almost ripe, when it usually falls. In liverworts the calyptra covers the capsule only very early in its development; later it may be visible as a collar at the base of the stalk.

Calystegia (bindweed; family Convolvulaceae) Genus of herbaceous and woody plants which have long, trailing and twining stems. They have alternate, simple leaves without stipules. The regular flowers are bisexual with an involucre of large bracteoles below the calyx. There are five sepals, and five petals fused to form a funnel or bell shape. The stamens are attached to the corolla base. The flowers are generally large and axillary. The ovary is superior, with two fused carpels and two locules, each with two ovules. The fruit is a dehiscent capsule containing hairy seeds with large, folded cotyledons. There are about 10 species found in temperate and subtropical regions of the world, some of which are grown as ornamentals.

Calytrix (family Myrtaceae) Genus of shrubs with xeromorphic foliage, found mainly on heaths and semi-arid sites of low fertility in *Eucalyptus* assemblages. The star-like, five-petalled flowers have a persistent reddish calyx which remains showy after the corolla has withered. There are 50 species, endemic to Australia.

calyx 1 Collective term for all the sepals of a flower. 2 Cup-shaped, plated body of pelmatozoan echinoderms. 3 Bowl-shaped depression at the top of a calcareous coral skeleton, usually formed by the upper edges of the septa.

camara (adj. camaral) One of the chambers within a chambered mollusc, e.g. a nautiloid or ammonite. *See also* Camaroidea.

camaral *See* camara.

Camaroidea (class Graptolithina) Extinct order of encrusting graptolites built of autothecae and indistinct stolothecae, with bithecae usually absent. The autothecae are differentiated into an inflated basal vesicle (camara) and a free, tubular, distal part. The bithecae are tubular. The stolothecae form a bifurcating network above the camarae or are embedded in extracamaral tissue. They are known only from the Lower Ordovician. The order consists of two families, with five genera.

cambering Consistent dip of strata towards local valley floors, in conflict with the general regional dip. It is well displayed in the English Midlands, where ironstone beds are cambered down over clays as much as 30 m below their original level. It is probably due to large-scale structural disturbance when permafrost thawed.

cambic horizon Weakly-developed mineral soil horizon of the middle part (B horizon) of soil profiles, and one that has few distinguishing morphological characteristics except for evidence of weathering and sometimes of gleying. It is found in brown earths and gleys. (USDA term.)

cambium In the stems and roots of vascular plants, a layer of cells lying between the xylem and phloem. These retain the ability to divide, producing secondary xylem and phloem. This continues throughout the lifetime of woody plants, increasing the girth of the stem. *See also* bark.

Cambrian First of six periods of the Palaeozoic Era. It began 570 million years ago and lasted approximately 70 million years. Sediments deposited during the period include the first organisms with mineralized skeletons. Common fossils include brachiopods, trilobites, ostracodes, and, late in the period, graptolites. Trilobites are important in the stratigraphic subdivision of the period.

Cambridioidea (phylum Mollusca, class Monoplacophora) Extinct order of elongate monoplacophorans that have a sharp apex. Some possess very poor bilateral symmetry. The order ranges in age from Lower Cambrian to Middle Cambrian.

camel *See* Camelidae.

camel cricket *See* Rhaphidophoridae.

Camelidae (camels; order Artiodactyla, infra-order Tylopoda) Family that includes the dromedary (*Camelus dromedarius*), Bactrian camel (*C. bactrianus*), guanaco (*Lama guanicoe*) and vicuña (*L. vicugna*). The dromedary is known only as a domestic animal; the Bactrian camel and guanaco have domestic forms (the domestic guanaco is called the llama). Another domestic camelid, the alpaca of the Andes, may be descended either from the guanaco or from a guanaco × vicuña hybrid. They are ruminants in which the stomach has three chambers. Horns and tusks are absent. Hoofs, present in earlier forms, have been replaced by wide pads on the two digits of each foot. The gait is swaying, as fore and hind legs of each side move together. There is a vacuity between the lachrymal and nasal bones. Camelids appear first as fossils in N. American rocks of Upper Eocene age. Until nearly the end of the Tertiary they were almost exclusively N. American, but in the Pliocene they entered S. America and Asia, and then spread into Africa. The late-Tertiary American forms included a 'gazelle camel' and 'giraffe camels'. Camels became extinct in N. America toward the close of the Pleistocene. Today *Camelus* species are native to the Old World, where they are nearly extinct in the wild, and *Lama* species to New World. There are two genera, with four wild species.

Camellia (family Theaceae) Genus of evergreen shrubs and small trees, many of which are grown for their showy flowers as ornamentals. *C. sinensis* is the tea plant; its variety *assamica* yields Indian tea. There are 82 species, occurring mainly in E. Asia.

Camellia japonica *See* Theaceae.

Camellia sinensis (tea plant) *See* Theaceae.

Camerata (class Crinoidea) Subclass of echinoderms, with thecal plates typically united by rigid structures composed of numerous small, polygonal plates, and some lower brachial plates, all firmly sutured together. The tegmen (upper surface of the theca, above and between the arms) is plated, some of the plates roofing over the mouth and ambulacral grooves. The Camerata are known from the Lower Ordovician to Upper Permian.

Camerothecida (phylum Mollusca, class Calyptoptomatida) Order of calyptoptamidids that lack an operculum. The shell is oval in cross-section, and chambered, but there is no through-chamber connection. The shell is almost parallel adjacent to the aperture. They are found only in rocks of Cambrian age.

camomile *See* chamomile.

c-AMP (cyclic AMP) Cyclic form of adenosine monophosphate, formed from ATP (adenosine triphosphate) in a reaction mediated (catalysed) by adenyl cyclase, which has numerous functions in cells. It can act variously as a genetic regulator, as a mediator in the activity of some hormones, as an enzyme activator, as a secondary messenger, and as a chemical attractant.

Campanula (bellflowers) *See* Campanulaceae.

Campanulaceae Family of (mostly) herbs, in which the leaves are alternate, simple, and exstipulate. The flowers are regular, usually bell-shaped, with the corolla-lobes fixed together below. The inferior ovary is 2–10-celled, with many ovules. The fruit is usually a capsule. *Campanula* (bellflowers) is a genus of more than 300 species, with erect stems, and blue, purple, or white flowers; many of these species are cultivated. There are 35 genera, with 700 species; they are of almost cosmopolitan, but mostly temperate, distribution.

campanulate Shaped like a bell.

Campbell–Stokes sunshine recorder Device that utilizes a glass sphere to concentrate the sun's rays on to a calibrated paper, where the resulting burns register the time and duration of sunshine. The instrument must be pre-set for a given latitude.

Campephagidae (cuckoo-shrikes, minivets; order Passeriformes) Family of small to medium-sized grey or brightly-coloured birds. They are long-winged and long-tailed; the bill is medium-sized, often hooked; and they have well-developed rictal bristles and spiny feathers on the lower back and rump. They are arboreal, tree-nesting, and insectivorous. There are nine genera, with 72 species, found in Africa, Asia, and Australasia. *Lalage sueurii* (white-winged triller) is unusual in having two annual moults.

camphor *See Cinnamomum*.

Campnosperma (family Anacardiaceae) Genus of tropical trees, which are fast-growing and which yield pale, soft, useful timber. There are 15 species.

campo cerrado The campos of Brazil comprises savannah-type vegetation associated with very poor soils, although in the absence of fire, woodland or scrub would no doubt prevail. There are several campos variants, including campo cerrado, which is a tree-covered savannah, and campo sujo in which the aspect is more open and trees and shrubs are sparse.

Campodeidae *See* Diplura.

campodeiform Applied to a type of larval form found in Neuroptera, Trichoptera, Strepsiptera, and some Coleoptera. The campodeiform larva is predacious, and has a well-sclerotized body with six legs. The whole body is flattened dorso-ventrally.

Camponotus (carpenter ants; order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Formicinae) Genus of large ants which includes some temperate species, e.g. *C. herculeanus* which excavates nest cavities in dead wood and which may do considerable damage to buildings and timber. The genus is distributed worldwide, and there are about 2600 species.

retaining some amphibian features, but distinctly reptilian in the form of their skulls, and differing from amphibians in the structure of the pelvic girdle. Because they were ancestral to all later reptile groups, the cotylosaurs are known as 'stem reptiles'.

capybara (*Hydrochoerus hydrochaeris*) *See* Hydrochoeridae.

Carabidae (ground beetles; class Insecta, order Coleoptera) Major family of generally black, brown, or metallic beetles. Their size ranges widely, from 2 to 35 mm long. They are often flightless, with fused elytra. The legs are long and slender, and adapted for running; in some species they are specialized for digging. The mandibles are prominent. Although most Carabidae are carnivorous, some species feed on plant material. Many species are nocturnal, hiding under stones during the day. Tiger beetles (e.g. *Cicindela campestris*) are thought to be the fastest-running land beetles, with speeds of almost 2.4 km per hour. Bombardier beetles (*Brachinus* species) deter attackers with puffs of caustic chemicals, dispelled audibly from the abdomen. There are 25 000 species, distributed worldwide.

Carangidae (jacks, scad, trevally; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of marine pelagic fish. All have streamlined bodies, with two separate dorsal fins, and a forked tail; and some (but not *Seriola*) have a series of scutes or comb-like scales along the caudal peduncle. The two anal spines are detached from the rest of the anal fin. Distributed widely in warm and temperate waters, many, especially the younger ones, travel in vast schools, but some of the larger ones are solitary. They range in size from the relatively small *Trachurus trachurus* (E. Atlantic scad), measuring up to 35 cm, to the much larger *Seriola dumerili* (amberjack). Some, e.g. *Elagatis bipinnulatus* (rainbow runner), have a torpedo-shaped body. Others, e.g. the Indo-Pacific *Alectis indicus* (plumed trevally), have a compressed, deep body.

carapace 1 The domed top of a chelonian shell (order Chelonia (Testudines)). It is composed of two layers: (a) an inner body capsule of interlocking plates (the median neurals associated with the vertebrae; the lateral costals associated with the ribs, and encircled by the marginals); (b) a covering of horny scutes, forming a similar pattern but not corresponding exactly to the underlying bones. 2 *See* cephalothorax.

Carapidae (pearlfish; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Family of small, somewhat eel-like, marine fish with very long dorsal and anal fins, but lacking pelvic and caudal fins. Many species have the peculiar habit of hiding in the body cavity of sea cucumbers. A fairly common species, *Carapus bermudensis*, has a semi-transparent body and leaves its host at dusk to feed; when returning it enters the posterior of its host, tail first. There are about 28 species, distributed in tropical and temperate seas.

carbohydrate Generic term for molecules that have a basic empirical formula of $(CH_2O)_n$ and that are aldehyde or ketone derivatives of polyhydroxyl alcohols. They are normally classified as mono-, oligo-, or poly-saccharides, depending upon whether they are single sugars, short-chain molecules, or large polymers respectively.

carbon Non-metallic element (symbol C) that forms many compounds containing chains or rings of carbon atoms and that occurs in all living organisms. It is extracted from carbon dioxide by plants during photosynthesis, is incorporated into living matter, and is oxidized back to carbon dioxide when that matter decomposes. Pure carbon occurs naturally as diamond and graphite, and is formed, as charcoal, by the destructive distillation of organic matter.

carbonaria Melanic form of *Biston betularia* (peppered moth), which is most common in soot-polluted woods surrounding industrial cities in the UK, as a result of selective predation by birds upon the normal (pale) form, which is more conspicuous in this habitat.

carbonate compensation depth (CCD) The depth in the sea at which the rate of dissolution of solid calcium carbonate equals the rate of supply. Surface ocean waters are usually saturated with calcium carbonate, so calcareous materials are not dissolved. At mid-depths the lower temperature and higher CO_2 content of sea-water cause slow dissolution of calcareous material. Below about 4500 m waters are rich in dissolved CO_2 and able to dissolve calcium carbonate readily. Carbonate-rich sediments are common in waters less than 3500 m depth, but are completely absent below about 6000 m. *See also* calcareous ooze.

carbonates (geol.) Group of minerals found mostly in limestones and dolomites. Calcite ($CaCO_3$) is the most abundant and most important. Aragonite has the same formula as calcite but is less stable; and dolomite or 'pearl-spar' contains magnesium, $CaMg(CO_3)_2$. The term 'carbonate' is frequently used with reference to those sedimentary rocks with 95% or more of either calcite or dolomite, and is synonymous with 'limestone'.

Carboniferous Penultimate period of the Palaeozoic Era, preceded by the Devonian and followed by the Permian. It lasted 65 million years, having begun 345 million years ago. In Europe the lower part of the period is termed the Dinantian. It is divided into two stages and is characterized by marine limestones with a rich coral-brachiopod fauna. In contrast the upper part, the Silesian, which is subdivided into three stages, is noted for the deposition of terrestrial and freshwater sediments. The vast forests of the Upper Carboniferous gave rise to the rich coal measures of S. Wales, England, Scotland, and many other areas worldwide. N. American geologists subdivide the Carboniferous into two periods or subperiods. Of these the lower is named the Mississippian and is the equivalent of the Dinantian stages (the Tournaisian and Visean). The upper period, the Pennsylvanian, is the equivalent of the Silesian.

carboxylase Enzyme that catalyses the incorporation of carbon dioxide into an organic compound.

for cutting. The face is long. The alisphenoid canal is present, the paroccipital process long. The diet is mainly carnivorous but some species eat significant amounts of plant material. There are 13 genera, with about 41 species. *Canis* species—e.g. the wolf (*C. lupus*), from which domestic dogs (*C. familiaris*) are descended, jackals (several species), and the coyote (*C. latrans*), etc.—are distributed worldwide except for Madagascar and some islands. They have been introduced to S. America and Australasia, where some are now feral (e.g. *C. dingo*, the dingo). *Lycaon* (Cape hunting dog) is confined to Africa. *Chrysocyon brachyurus* (maned wolf) is restricted to parts of tropical S. America. *Atelocynus microtis* (small-eared dog, or zorro) is also S. American. *Cuon alpinus* (dhole) is distributed throughout much of Asia. The bush dog (*Speothos venaticus*) hunts in small packs in the S. American tropical forests. *Nyctereutes procyonoides* (raccoon dog) is a fox-like animal with facial markings reminiscent of those of a raccoon: it is distributed throughout much of Eurasia. Foxes of the *Vulpes* genus (e.g. *V. vulpes*, the red fox) and the *Alopex* genus (e.g. *A. lagopus*, the arctic fox) are distributed throughout the Holarctic and N. Africa. *Dusicyon* foxes are confined to S. America. The fennec (*Fennecus* or *Vulpes zerda*) is confined to Africa; the crab-eating fox (*Cerdocyon thous*) and several related species to tropical S. America.

canine 1 Pertaining to a dog. 2 Conical, pointed tooth situated between the incisors and premolars. In some mammals it is enlarged to form a tusk, in others it is reduced or absent.

canker General term for a localized disease of woody plants in which bark formation is prevented. Cankers may be caused by bacteria or fungi, or occasionally even by viruses.

Canna (family Scitamineae) Genus of rhizomatous herbs that are cultivated for their showy inflorescences. *C. edulis* of the Andes is cultivated for its edible rhizomes (Queensland arrowroot, or achira). There are 55 species, occurring in tropical and subtropical America.

Cannabidaceae Small plant family, closely related to Moraceae (but differing from it mainly in having its floral parts in fives), of herbs without latex, with lobed, stipulate leaves, and small, dioecious flowers borne in axillary clusters. The perianth is pentamerous; there are five stamens: and the ovary is unilocular, with two stigmas. The flowers are wind-pollinated. The fruit is a small nutlet. *Cannabis* produces the fibre hemp and also a narcotic drug (its cultivation is now illegal in many countries). *Humulus*, a climbing plant, is used to flavour beers. There are two genera, *Cannabis* (hemp) and *Humulus* (hop), of northern temperate distribution.

Cannabis (family Cannabidaceae) Genus comprising one species, *C. sativa* (hashish, hemp, ganja, marijuana), native to central Asia, which is a large herb that provides a narcotic as well as hemp fibre.

cannibalism The eating by an animal of members of its own species. It is known to occur in nearly 140 species, most commonly among invertebrates, and often (but not always) in response to stress or to a reduction in the availability of other food.

cannon bone In Artiodactyla, a single bone formed usually by the fusion of the third and fourth distal tarsal bones, and in horses by the enlargement of the third distal tarsal bone.

Canoidea (superorder Ferae, order Carnivora) Superfamily comprising the dogs (Canidae), the bears (Ursidae), the raccoons (Procyonidae), and the weasels (Mustelidae). These are relatively unspecialized carnivores whose evolution shows tendencies to move from a carnivorous diet to one containing increasing amounts of plant material, and eventually (e.g. some bears, and pandas) to a fully herbivorous diet.

canopy (ecol.) Usually, the distinctive microenvironment formed in the upper level of woody communities where tree branches and leaves are most dense. In complex communities, e.g. in tropical rain forest, the canopy layer may be subdivided into distinctive emergent, middle, and lower zones. The term may also be applied to the upper layer of shrub and scrub communities, or in any terrestrial plant community in which a distinctive habitat is formed in the upper, denser regions of the taller plants. *Compare* ground layer.

cant The section of a coppiced woodland that is cut in a particular year in the rotation. *See also* coupe; and hag.

Cantharellus (family Cantharellaceae, order Agaricales) Genus of fungi in which the fruit body consists of a more or less funnel-shaped pileus with a central stipe. The hymenium is borne on wrinkles, or blunt gill-like ridges on the lower, or outermost, surface of the pileus. The genus includes the edible 'chanterelle'.

Cantharidae (soldier beetles, sailor beetles, leather-winged beetles; class Insecta, order Coleoptera) Family of soft-bodied, pubescent beetles, 3–18 mm long, in which the elytra are parallel-sided, without striae, and often brightly coloured, commonly red, or black. The antennae are long, and filiform. The beetles are frequently found at flowers. The larvae are rather flattened, with a well-marked head, long legs, and a two-pronged tail; usually they are dark and pubescent. They are found under bark and logs and in loose soil. They are active in winter, hence their name 'snow-worms'. Both adults and larvae are predatory on insect grubs, though some are omnivorous. There are 3500 species.

carcajou (glutton, skunk bear, wolverine, *Gulo gulo*) *See* Mustelidae.

Carcharhinidae (whaler shark, blue shark, tiger shark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Large family of mainly pelagic sharks, characterized by having the last of the five gill slits placed over the origin of the pectoral fin; a narrow, slit-like spiracle; and the first and largest of the two dorsal fins placed well forward. These sharks have a generally drab brown to blue colour, being lighter underneath. Some species (e.g. *Prionace glauca*, blue shark, which can

reach a length of 3.5 m), have a worldwide distribution, avoiding only the polar seas. *Galeocerda cuvieri* (tiger shark) also inhabits many oceans and can reach a length of 5 m. It belongs to the viviparous sharks, producing up to 46 live young at a time. There are about 85 species, including species such as *Mustelus mustelus* (smooth hound, or dogfish), which sometimes is placed in another family (Triakidae).

Carchariidae *See* Odontaspididae.

Carcharodon carcharias (white shark) *See* Lamnidae.

carcinogen Physical or chemical agent that transforms a normal cell into one that is malignant.

Carcinus maenas (green crab, shore crab; order Decapoda, family Portunidae) Species of crab that runs sideways in shallow water between tides. Most individuals are active at night and at high tide, feeding on molluscs, amphipods, shrimps, worms, and small fish. Females grow up to 5.5 cm wide, males up to 8 cm. If threatened the crabs raise themselves and attack with their chelipeds. Premoult attendance of the females results in freshly-moulted females being mated by their attendant males, for up to four days. The species occurs from Nova Scotia to Virginia, and from N. Norway to NW Africa.

Cardamine (family Cruciferae, tribe Arabideae) Cosmopolitan genus of plants found in temperate and cool-temperate regions. Eight species are endemic to Australia and New Zealand.

cardamon (*Elettaria*) *See* Zingiberaceae.

carder bees *See* Megachilidae.

cardiac glycoside Generic term for a group of steroid glycosides that includes oubain and digitalis, which increase cardiac output. They act by stimulating systolic contraction of the heart muscle. They can also inhibit *in vivo* the sodium-pump mechanism of cell membranes.

cardinal (*Cardinalis cardinalis*) *See* Cardinalidae.

cardinal beetle *See* Pyrochroidae.

cardinal fish *See* Apogonidae.

Cardinalidae (cardinals, grosbeaks, saltators; order Passeriformes) Family of medium to large, heavy-bodied finches with large conical bills: the males are often highly coloured. They inhabit woodland, feeding on fruit, seeds, blossoms, and insects and are tree-nesting. *Cardinalis cardinalis* (cardinal) is a common cagebird. There are 8–13 genera, with 39 species; often combined with Fringillidae or Emberizidae, and found in N., C., and S. America.

Cardinalis cardinalis (cardinal) *See* Cardinalidae.

cardinal tooth Large hinge tooth present in some pelecypods which is immediately below the umbo. More than one may be present on each valve.

Cardiomanes (family Hymenophyllaceae) Genus of filmy ferns centred in New Zealand, with thin, simple, heart- or kidney-shaped fronds, and marginal soralia with bristle-like receptacles on which sporangia are borne, enclosed in tubular indusia.

Cardiopteridaceae Family of one genus and three species of plants found in SE Asia, with one of these species also occurring in Australia.

Cardiosoma guanhumi (land crab; order Decapoda, family Gecarcinidae) Species of land crab that weighs up to 500 g and is 11 cm wide when mature. It lives mostly above the high-tide mark and can move up to 8 km inland, where it may burrow up to 2 m deep and search for food in shady areas at any time of day. Its food comprises fruit, leaves, and carrion, which is taken back to the burrow. When the population density is high, open fields, mangroves, and coconut plantations may be ploughed up with these burrows. The crabs can tolerate high levels of nitrogenous waste in their blood and stomachs, and may store up to three days' accumulation of waste products. Although terrestrial in habit, the distribution of *Cardiosoma* is coastal because of the dependence on the ocean for reproduction. Large numbers of females migrate to the ocean at full moon to shed their eggs. The species occurs in Bermuda, the W. Indies, and Florida.

Carduelis (goldfinches, greenfinches, siskins; family Fringillidae) Genus of mainly yellow or green finches. They are seed-eating and are found in forests, woodland, and open country where they build open nests in trees and shrubs. *Carduelis carduelis* (goldfinch) and *C. chloris* (greenfinch) have been introduced successfully to Australia and New Zealand. There are 24 species, found in N., C., and S. America, Europe, N. Africa, and Asia

Carduelis carduelis (goldfinch) *See Carduelis*.

Carduelis chloris (greenfinch) *See Carduelis*.

Caretta caretta (loggerhead turtle; order Chelonia (Testudines), suborder Cryptodira, family Cheloniidae) Species of turtles found in all tropical and subtropical seas, and occasionally reaching the British coast. They have a smooth, chestnut-coloured carapace up to 130 cm long. The plastron is yellowish. They are essentially carnivorous (the diet includes crustaceans, molluscs, echinoderms, and fish) but some vegetation is eaten. They lay 120–150 eggs.

Carettochelyidae (pitted-shell turtle; order Chelonia (Testudines), suborder Cryptodira) Family of turtles which contains one species, *Carettochelys insculpta*, found in the rivers of S. New Guinea. The bony shell is complete, but skin-covered, lacking horny scales. The nose has a short breathing proboscis, but lung respiration is supplemented by cutaneous surfaces. The family is believed to be intermediate between Emydidae and Trionychidae.

Carex (sedges; family Cyperaceae) Genus of perennial herbs that have rhizomes. The stems are characteristically triangular in cross-section, solid, and leafy. The leaves are linear, often inrolled or keeled, with a sheathing leaf base, and a ligule. The inflorescence varies from a branched panicle to a single spike, and is composed of unisexual flowers, usually clearly separated on the inflorescence, the plants being generally monoecious. Each single-flowered spikelet is subtended by a glume. There is

no perianth, although the female flowers are surrounded by a triangular or flattened sac with a beak through which the two or three stigmas project from the triangular or oval ovary. The ovary is superior, with three fused carpels and a single locule. The fruit, a small nut, remains within the sac, and contains copious endosperm. The male flowers have two or three stamens, and are generally held at the top of the inflorescence, often in the terminal or upper, later spikes. The female flowers are restricted to the lower branches or the bottom of the spike. The sedges are found throughout the world, often as components of marshy habitats. Each species has very precise ecological requirements. There are more than 1000 species, of which a limited number are used locally as food or bedding for animals, and a few are cultivated as ornamentals.

Cariama *See* Cariamidae.

Cariamidae (seriemas; order Gruiformes) Family of long-necked, long-legged, greyish-brown birds with rounded wings, long tail, and a crest. They have small and semipalmate feet, and are rapid runners but poor fliers. They inhabit grassland and forests, feeding on insects, reptiles, small mammals, and vegetable matter, and nest in trees and bushes. There are two monotypic genera, *Cariama* and *Chunga*, found in C. and S. America.

Caribbean current Powerful, warm, ocean water current which flows westward through the Caribbean Sea, passes into the Florida current, and thus contributes to the Gulf Stream. Its flow velocity averages 38–43 cm/s.

Caribbean floral region Part of Good's (1974) Neotropical kingdom. It comprises isthmian America and the W. Indies. There are thought to be well in excess of 500 endemic genera, and many thousands of endemic species. Some of the most diverse floras in the world are found here. For example, Cuba alone has roughly 8000 species, many of which are endemic. A very large number of valuable economic plants and some garden plants are from this region.

caribou (reindeer, *Rangifer tarandus*) *See* Cervidae.

Carica (family Caricaceae) Genus of small trees which have pithy trunks, supported by phloem tissues. Several species have edible fruits, notably *C. papaya* (papaya), now very widely cultivated, whose leaves and unripe fruit contain a proteolytic enzyme, used to tenderize meat. There are 45 species, found in the American tropics.

Caricaceae Family of small trees which have few branches, or none. The sap is watery to milky. The leaves are palmately lobed, or divided. The flowers are regular, mostly unisexual. The fruit is a berry. The family is related to Passifloraceae. There are four genera, with 55 species, occurring in the tropics of America and Africa.

caries Condition in which bones or teeth decay and (eventually) disintegrate. *See also* dental caries.

cariogenic Applied to any factor that leads to or encourages the formation of caries.

Carludovicia (family Cyclanthaceae) Genus of trees that have a short stem, and tufted, palmate leaves. The flowers are borne on a spadix, which at first is enveloped by bracts, developing later into a head of berries. Young leaves of *C. palmata* (Panama-hat palm) provide the fibre for Panama hats. There are three species, occurring in the northern part of tropical America.

carnallite Mineral, specific gravity 1.6, hardness 1.0–2.0, chemical composition $KMgCl_2.6H_2O$, named after the nineteenth-century mining engineer R. V. Carnall, which occurs in evaporite deposits and absorbs water readily. It is distinguished by its low hardness, specific gravity, lack of cleavage, and bitter taste. It is normally white, and occasionally yellowish and reddish, and it has a greasy lustre. It crystallizes in the orthorhombic system. It is found massive and granular, with the pseudo-hexagonal crystals being rare. It is used as a fertilizer.

carnassial In many Carnivora, a modification of premolar or molar teeth, commonly the lower first molar and the upper last premolar, giving them a scissor-like shearing action used for cutting flesh.

carnation *See Dianthus*.

carnauba wax Major source of wax for polishes, obtained from the leaf surfaces of *Copernicia cerifera* (fan palm) of the dry north-eastern shoulder of Brazil, where it is exceedingly abundant in open savannah forest. A tribe of Indians, the Carnaubeira, was almost completely dependent on its products. *See also Copernicia*.

carnitine Compound found in animal cells that functions in both fatty-acid synthesis and oxidation. It also facilitates the transport of fatty-acyl groups across the inner mitochondrial membrane.

Carnivora (cohort Ferungulata, superorder Ferae) Order comprising the modern, carnivorous, placental mammals, and their immediate ancestors. It is divided, on grounds of taxonomic convenience rather than ancestry, into two suborders: the Fissipedia (mainly land-dwelling), and the Pinnipedia (seals, sea lions, walrus). The carnivores are descended from a single stock of the probably insectivorous, placental mammals of the early Cretaceous, the change being reflected in their dentition. Strong incisors for biting, and canines for piercing, were retained from the insectivorous forms, but in general carnivores acquired modified cheek teeth (carnassials) specialized for shearing. These subsequently became reduced in carnivores, which then adopted a herbivorous diet. Hoofs have rarely developed, as claws are used for seizing prey, and digits are never greatly elongated (and, apart from the pollex and hallux, they are not reduced). The first true carnivores were the weasel-like Miacidae of the Palaeocene, which had diverged by the end of the Eocene to give the Canidae (dogs) and the Mustelidae (weasels and their allies) as one branch and the Viverridae (Old World civets) and Felidae (cats) as another. The Mustelidae later branched again to give the Phocidae (seals); and the Canidae diversified widely to produce such forms as

the Amphicyonidae ('dog-bears'), the Otariidae (sea lions), the Procyonidae (raccoons and pandas) and, ultimately, the Ursidae (bears). Finally the Hyaenidae (hyenas) emerged in the late Miocene from viverrid stock; this is the youngest of the carnivore families.

carnivore Heterotrophic, flesh-eating animal feeding on herbivores, detritivores, or other carnivores. *See also* food-chain.

Carnosa (class Gymnolaemata, order Ctenostomata) Suborder of bryozoans, in which the individuals of a colony (zooids) bud laterally from the first-formed zooid, in line with each other. They are known only in the Recent.

carnosaur Saurischian (lizard-hipped), carnivorous dinosaur. Carnosaurs were bipedal, powerfully built, and possessed large, dagger-like teeth. *Tyrannosaurus rex*, of the Upper Cretaceous, represented the culmination of the carnosaur line.

carnotite Mineral, specific gravity 4.5, hardness 2.0–2.5, and with the chemical composition $K_2(UO_2)_2(VO_4)_2.3H_2O$, which occurs in the weathered zone of sedimentary rocks, especially in sandstones enriched with organic matter. Normally it is bright yellow to greenish yellow, with a pearly lustre. It crystallizes in the monoclinic system. The mineral normally occurs as coatings and masses in rock. It is strongly radioactive and is a source ore for uranium.

Carolina box turtle *See Terrapene carolina*.

Carophylliina (order Madreporaria) Suborder of solitary or colonial corals which appeared first in the Lower Jurassic. They are like the related suborder Fungiina, but lack synapticulae and have laminar septa with smooth or nearly smooth margins. The suborder contains four families, with 93 genera.

carotene One of a group of hydrocarbon carotenoids.

carotenoid Generic term for water-insoluble, polyisoprenoid pigments which often function as accessory photosynthetic pigments in higher plants and photosynthetic bacteria, with absorption peaks between 450 and 480 nm.

carotid artery One of a pair of arteries supplying blood to the head.

carp (*Cyprinus carpio*) *See* Cyprinidae.

carpal One of the bones of the wrist that articulate with the digits.

carpal spur Sharp, horn-covered bone, situated on the carpus of birds, and used in combat. It is found in some Anatidae and Charadriidae, and in all Chionididae, Jacanidae, and Anhimidae.

carpel One of the female reproductive organs of the flower, i.e. a unit of the gynoecium, comprising an ovary (containing one to many ovules borne on a placenta) and with a usually terminal style tipped by the stigma.

Carpentaria (family Palmae) Monotypic genus (*C. acuminata*) endemic to tropical Australia and found as a component of semi-evergreen vine forests.

carpenter ant *See Camponotus*.

carpenter bees 1 *See* Anthophoridae. 2 *Xylocopa*. *See* acarinum.

carpenter moths *See* Cossidae.

carpet beetle (*Anthrenus genus*) *See* Dermestidae.

carpet moths 1 *See* Geometridae. 2 *See* Tineidae.

carpet shark *See* Orectolobidae.

carp gudgeon (*Hypseleotris compressus*) *See* Eleotridae.

Carpinus (hornbeams; family Betulaceae) Genus of monoecious, catkin-bearing trees, in which the male flowers are without bracteoles, and have about ten, forked stamens. The female flowers are borne in terminal, drooping catkins. The fruit is a small nut with a large, three-lobed, bract-like, or leafy involucre on one side. Hornbeams are smooth-barked trees, with simple leaves, at one time much coppiced in Europe. The wood was also used formerly to make wooden gear wheels, on account of its toughness. It is now little used. There are about 25 species, occurring in the northern temperate zone, and in C. America.

Carpo brotus (Hottentot fig) *See* Aizoaceae.

Carpodacus (rosefinches; family Fringillidae) Genus of birds in which the males are various shades of red and purple, some with silvery head feathers; females are brown or grey. They are found in forests, scrub, and open country, feeding on seeds and nesting mainly in trees and bushes. There are 21 species, found in N. America, Mexico, Europe, and Asia.

carpogonium Female sex organ (gametangium) in seaweeds belonging to the class Rhodophyceae. Usually it consists of a swollen basal region, and a narrow, elongated, gelatinous tip which receives the male gamete.

Carpoidea Extinct class of Lower Palaeozoic echinoderms, which are unimportant in the fossil record. They ranged from Cambrian to Devonian times.

carpoids (phylum Echinodermata) Informal collective term describing the homalozoan classes Homoiostelea, Homostelea, and Stylophora.

Carpolestidae (order Primates, infraorder Plesiadapiformes) Extinct family of Palaeocene and Eocene primates. They were animals about the size of shrews which probably lived on the forest floor, and which may have been herbivorous. They had claws rather than nails; enlarged, chisel-like incisors; and enlarged lower premolars. The ear region of the skull is reminiscent of lemuroids, but they are not ancestral to any modern primates.

carpus The wrist joint, which in a bird forms the outer joint of the wing.

carr Locally-variable term, of Scandinavian origin, used to describe wet habitats, usually with some peat development but with neutral (not extremely acidic) waters and with good nutrient status. In East Anglia, England, the name refers especially to

wooded wet areas, typically alderwoods (*Alnus glutinosa*); but where nutrient levels are less favourable, willow, particularly *Salix cinerea*, may be the principal tree species. Elsewhere the term refers more generally to fenland. *See also* fen; *compare* bog.

carrageenan *See* carragheen.

carragheen (carrageenan) Complex polysaccharide obtained from certain red seaweeds (Rhodophyceae), especially from *Chondrus crispus* ('Irish moss') and *Gigartina* species. Carragheen has a number of commercial uses as a stabilizer in paints, pharmaceutical products, and various types of food such as sauces and creams. (The term 'carragheen', but not 'carrageenan', may also be used to refer to the seaweed *Chrondrus crispus* itself.)

carrier (of disease) Individual who carries an infective pathogen in his body and who can convey the pathogen (and hence disease) to others without necessarily contracting the disease himself.

carrion beetle *See* Silphidae.

carrot *See Daucus*.

carrying capacity The maximum population of a given organism that a particular environment can sustain; the K (saturation) value for species populations showing S-shaped population-growth curves. It implies a continuing yield without environmental damage. It may be modified by human intervention to improve environmental potential, e.g. by applying fertilizers to rangeland and reseeding it with nutritious grasses.

cartilage In vertebrates, flexible skeletal tissue formed from groups of rounded cells lying in a matrix containing collagen fibres. It forms most of the skeleton of embryos and in adults is retained at the ends of bones, in intervertebral discs, and in the pinna of the ear; in Elasmobranchii calcified cartilage rather than true bone provides the entire skeleton.

cartilaginous fish Fish in which the skeleton, including the skull and jaws, consists entirely of cartilage and never, even in the adult stage, comprises bony tissue. In mature sharks part of the skeleton may calcify due to impregnation with calcium salts, but no bone is ever formed. Sharks and rays (Chondrichthyes) have a cartilaginous skeleton, as have other lower vertebrates, e.g. the jawless lampreys and hagfish (Agnatha).

Cartonemataceae Family of one genus comprising seven species of plants native to tropical SW and W. Australia.

caruncle Reduced aril, in the form of a fleshy, often waxy or oily, outgrowth near the hilum of some seeds. Usually it is brightly coloured. It acts as an aid to dispersal. *Viola* seeds have an oily caruncle and are sought and dispersed by ants.

Carya (hickory; family Juglandaceae) Genus of trees in which the leaves are pinnate, and the wood is tough, and springy. The fruit is a drupe with an edible seed (pecan). There are 25 species, found in E. Asia and N. America.

Carybdeida Alternative name for Cubomedusae.

Caryophyllaceae Family, mostly of herbs, in which the leaves are simple, opposite, normally entire, and exstipulate. The flowers are usually borne in terminal, forked cymes (dichasia) with a central flower in each fork: they are regular, with usually four or five free petals, four or five stamens, or twice as many stamens as petals; and a superior ovary, which is syncarpous, one-celled with many ovules on a free central placenta, and has two to five styles. The fruit is usually a capsule. Some genera (*Dianthus*, *Saponaria*, etc.) are much cultivated for the flowers. There are 70 genera, with about 1500 species, most of them found in the northern temperate region.

Caryophyllidea (phylum Platyhelminthes, class Cestoda) Order, or in some classifications family, of parasitic, platyhelminth worms which possess one set of genitals. The scolex may have suckers. Most inhabit two hosts during their development.

caryopsis Dry, nut-like fruit typical of grasses, e.g. a cereal grain.

Caryota (fishtail palms; family Palmae) Genus of palms which are small to 30 m tall, and solitary or clump-forming; they are unique among palms in having leaves that are twice-pinnate, with the leaflets fishtail-shaped, and pinnately nerved. The inflorescences develop basipetally, the female flower flanked by two males. The fruits have an irritant, sappy pericarp, and contain one or two seeds. They are native from tropical Asia to Queensland, and in the Solomon Islands.

Casearia (family Flacourtiaceae) Genus of 160 species of small to medium tropical trees. The leaves have translucent points or lines.

cashew (*Anacardium occidentale*) *See Anacardium*.

casque Helmet; in some vertebrates, a bony process on the top of the head.

cassava *See Manihot*.

Cassia (family Leguminosae, subfamily Caesalpinoideae) Genus of small to medium trees in which the leaves are pinnate. The flowers are slightly zygomorphic,, and showy. Several species are widely grown as ornamentals. The purgative senna is prepared from the leaves. There are 500 species, occurring in tropical to warm-temperate regions.

Cassiduloida (class Echinoidea) Order of irregular echinoids with petaloid ambulacra on the upper surface. The periproct is outside the apical system. There are large pores and swellings around the peristome, and no jaws or gill slits. The Cassiduloida first appeared in the Jurassic.

Cassinia (family Compositae) Genus of shrubs with small leaves and white to yellow flowers, differing from typical daisies in having no radial bracts, but only small flower heads. They are found mainly in Australia but also in New Zealand and S. Africa, with 18–20 species endemic to Australia, mainly in open forest.

cassiterite (tinstone) Mineral, specific gravity 6.8–7.1, hardness 6.0–7.0, chemical composition

SnO_2, whose name is derived from the Greek for 'tin'. It occurs typically in high-temperature hydrothermal veins, associated with granites and pegmatites. Associated minerals are topaz, quartz, tourmaline, mica, chlorite, and high-temperature metallic ores. It also occurs worldwide in alluvial deposits because of its stability against both chemical and physical attack. It is distinguished by its high specific gravity, lustre, and crystal form. It is usually reddish-brown to nearly black, but it can be yellowish and ruby. It has a white to grey streak, and an adamantine lustre. It crystallizes in the tetragonal system. The crystals are often pyramidal and prismatic, and they can also be massive and granular. It is one of the few tin minerals, and the only commercial ore for tin.

cassowaries *See* Casuariidae; Casuariiformes; and *Casuarius*.

Cassytha Aberrent genus of Lauraceae, comprising 20 species of slender, woody, parasitic twiners of the Old World tropics, which attach to host stems by haustoria.

Castanea (family Fagaceae) Genus of trees which yield useful timber and fruit (*C. sativa* is the Spanish or sweet chestnut), and which are also suitable for tanning. The fruits are entirely enclosed in a spiny cupule. There are 12 species, occurring in northern temperate regions.

Castanopsis (family Fagaceae) Genus of medium trees in which the fruits are entirely enclosed in a warty or spiny cupule. A few of the fruits are edible. There are 120 species occurring in tropical and subtropical Asia, and one species in N. America.

Castanospermum (family Leguminosae, subfamily Caesalpinoideae) Genus of two species of plants occurring in Australia and New Caledonia. *C. australe* has edible seeds (Moreton Bay chestnut) and fine timber (black bean).

caste 1 In social insects, the existence of more than one functionally-different form (polymorphism) within the same sex in the same colony, characterized by morphological features, age, or both. In bees and wasps, the female morphological castes are queens and workers. Within hive bees there are three castes, each performing a special function in the colony: non-reproductive workers (females that are usually sterile but help with provisioning of food for the queen in the hive); drones (reproductive males); and queens (fertile females). In termites, castes are not distinguished by sex: worker and soldier termites may be sterile males or females. There are several different kinds of workers among ants; all of which are sterile females, and ants also have a soldier caste. 2 System of social classification in humans, in which membership is determined culturally by birth and remains fixed; the group is ranked in a hierarchy of groups in the system.

caste determination In social insects, the process by which embryological development is influenced by physiological and environmental factors, giving rise to the various castes.

castellanus From the Latin *castellum*, meaning 'castle', a cloud species commonly associated with the upper parts of altocumulus, stratocumulus, cirrus, and cirrocumulus. Cumuliform, turreted protrusions extend in linear fashion from the cloud top, producing a crenulate form. *See also* cloud classification.

caste polyethism *See* polyethism.

Castniidae (order Lepidoptera) Fairly small family of medium-sized, colourful, day-flying moths, often with clubbed antennae. They resemble some butterflies. Frequently the hindwing, but not the forewing, is coloured. The adults feed on flowers; the larvae feed on plant stems and roots. There are about 200 species. The family is represented in the Neotropical, Australasian, Indo-Malay, and Madagascar regions.

Castoridae (beavers; order Rodentia, suborder Sciuromorpha) Family of semi-aquatic rodents with dense fur; valvular nostrils and ears; enlarged, webbed hind feet; strongly-clawed pentadactyl limbs; horizontal, scaly, paddle-like tails; and small eyes and ears. Both sexes possess paired anal scent glands. The skull is massive, the cheek teeth rooted and hypsodont. There are two species in a single genus, *Castor*, which has a Holarctic distribution.

castor oil (*Ricinus communis*) *See Ricinus*.

castrate Remove the testes from an animal. Domesticated animals are often castrated to prevent unwanted progeny.

Casuariidae (cassowaries; order Casuariiformes) Family of one genus, *Casuarius*, containing three species. They are related to Dromaiidae (emus).

Casuariiformes (cassowaries, emus; class Aves) Order of large ratites, with coarse, hair-like plumage, and three toes. There are two families, Casuariidae and Dromaiidae, confined to Australasia.

Casuarina (family Casuariaceae) Genus of xeromorphic trees in which the twigs are slender, cylindrical, green, and grooved with whorls of minute scale leaves at the nodes. The flowers are tiny, borne in compound spikes, and becoming woody in fruit, like small cones. They are wind-pollinated. The roots have nitrogen-fixing nodules. The genus may perhaps be related to the Hamamelidaceae. There are 65 species, occurring from the Mascarenes to Polynesia, with most species in Australia.

Casuarius (cassowaries; family Casuariidae) Genus of large, heavy-bodied ratites with black, hair-like plumage; the wing feathers have bare quills and there are no tail feathers. The head and neck are featherless with a casque, the bill is short and strong, and there are wattles on the neck. The legs are stout with three toes, the inner toe having a long sharp claw. Cassowaries are rainforest dwellers, feeding mainly on fruit and berries and nesting on the ground. There are three species, found in Australia, New Guinea, and neighbouring islands.

CAT *See* clear-air turbulence.

cat *See* Felidae.

catabolism The part of cellular metabolism encompassing the reactions that yield energy through the degradation of food molecules.

cataclasis *See* cataclasite.

cataclasite Rock that has been deformed by the process of shearing and granulation (cataclasis). Cataclasites are associated with tectonism and can be described as the products of dislocation metamorphism. *See also* mylonite.

catadromous Applied to the migratory behaviour of fish that spend most of their lives in fresh water but travel to the sea in order to breed there, e.g. *Anguilla anguilla* (European eel), which travels across the Atlantic when mature in order to spawn in the Sargasso Sea.

Catagonus *See* Tayassuidae.

catalase Haemoprotein, oxidizing enzyme, present in all aerobic organisms, which catalyses the decomposition of hydrogen peroxide to water and oxygen. It is the fastest-acting enzyme known, with a turnover number of 6×10^6. It is found in the tissues of animals and is particularly concentrated in the peroxisomes of cells.

Catalpa (family Bignoniaceae) Genus of small trees, several of which are cultivated for their showy flowers (e.g. *C. bignonioides*, Indian bean). There are 11 species, occurring in E. Asia and from southern N. America.

catalysis The acceleration of a chemical or biochemical reaction brought about by the action of a catalyst. The catalyst, which is not affected by the overall reaction, acts by either lowering the activation energy of the reaction through a reorientation of molecules in collision, or by facilitating an alternative mechanism that has a different activation energy. Enzymes are naturally-occurring catalysts which are universally present in all living cells. Enzymes are generally much more efficient and more specific than other catalysts.

Catamblyrhynchidae (plush-capped finch; order Passeriformes) Monotypic family comprising *Catamblyrhynchus diadema*, a short-billed finch with grey upper-parts and chestnut under-parts. Its forecrown has stiff, erectile yellow feathers. It inhabits forest edges and clearings, and is insectivorous. It is found in S. America.

Catamblyrhynchus diadema (plush-capped finch) *See* Catamblyrhynchidae.

catamount (*Puma concolor*) *See Puma*.

catarrhine In Primates, applied to nostrils that are close together and open downward.

Catarrhini (cohort Unguiculata, order Primates) Suborder of primates, including Old World monkeys, apes, and man. Many authorities place the Catarrhini with the Platyrrhini and Tarsioidea in a single order, Haplorhini. The earliest-confirmed catarrhines are known from the Oligocene of Egypt, though possible representatives are known from the Eocene of Burma.

catastrophe Sudden climactic event in geological times that resulted in radical change.

catastrophic evolution (catastrophic speciation) Theory proposing that environmental stress might lead to the sudden rearrangement of chromosomes, which in self-fertilizing organisms may then give rise sympatrically to a new species. Recent research suggests that at best this explanation applies to some special cases.

catastrophism Theory that associates past geological change with sudden, catastrophic happenings. Early geologists, including Buckland, Cuvier, and Sedgwick, claimed that catastrophism was a sound scientific theory: although it met with considerable scorn in more recent times, many modern geologists would describe themselves as 'neocatastrophists'.

catbirds *See* Ptilonorhynchidae.

catecholamine Dihydroxyphenylalkylamine derivative of the amino acid tyrosine: adrenalin and noradrenalin are two such derivatives. Many catecholamines act as neurotransmitters.

catena Topographic sequence of soils, of the same age and usually on the same parent material, that is repeated across larger landscape transects. Individual soil-profile types are related to site conditions and to position on a slope. The term was introduced in E. Africa in the 1930s, and is mainly applicable in certain non-glaciated landscapes, particularly those with small, hilly relief, e.g. loess areas.

caterpillar Larval stage of Lepidoptera, although sometimes the term is also applied to larval Symphyta (sawflies).

caterpillar-hunting wasps *See* hunting wasp; and Pompilidae.

catfish *See* Ageneiosidae; air breathing in fish; Amblycipitidae; Aspredinidae; Bagridae; Callichthyidae; Cetopsidae; Clariidae; Pangasiidae; Pimelodidae; Plotosidae; Schilbeidae; Siluridae; Sisoridae; and Trichomycteridae.

Catharanthus (family Apocynaceae) Genus comprising five species of tropical herbs. *C. roseus*, a showy ornamental and often a weed, produces important medicinal alkaloids.

Cathartidae (New World vultures, condors; order Falconiformes) Family of large, long-winged, brownish-black vultures with bare heads, often coloured. Their nostrils are perforate and many have a ruff of feathers around their neck. Their feet are weak with a small hind toe. They inhabit forests, mountains, and plains, feeding on carrion and nesting in caves or hollow trees. *Gymnogyps californianus* (California condor) is nearly extinct. There are five genera, eight species found in N., C., and S. America. See also *Vultur*.

cathepsin One of a group of intracellular proteinases that occur in most animal tissues, but especially in the kidney, liver, and spleen. They are often active only in the presence of certain reducing substances, e.g. cysteine, hydrogen cyanide, ascorbic acid, and hydrogen sulphide.

Catherine's moss Common name for the moss *Atrichum undulatum* (order Polytrichales). The shoots are erect, up to 7 cm tall. The leaves are dark

green, long and narrow, with characteristic transverse undulations, and toothed margins. The capsule is cylindrical, and curved, with a long beak on the lid. The moss is found on the ground in woods, also on heaths and waste ground.

cation Ion carrying a positive electrical charge, e.g. the metallic element of salt compounds: it can combine with certain anions (which have negative charges).

cation exchange Process in which cations in solution are exchanged with cations held on the exchange sites of mineral and organic matter, particularly on the surfaces of colloids of clay and humus.

cation-exchange capacity (CEC) The total amount of exchangeable cations that a particular material or soil can adsorb at a given pH. Exchangeable cations are held mainly on the surface of colloids of clay and humus, and are measured in milligram-equivalents per 100 g of material or soil.

catkin Pendulous spike, usually of simple, unisexual flowers.

Catostomidae (suckers; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Fairly large family of freshwater fish: they resemble minnows, but are recognizable by their protrusible sucker-mouth which is used to ingest organic material from the river bottom. Many have large scales, a single dorsal fin, and a body that is round in cross-section. Schools of mature suckers are known to undertake spawning migrations upstream in the river. The white sucker (*Catostomus commersoni*) is well regarded by fishermen, and is found in streams and lakes of Canada and the northern USA. Although most of the 58 species live on the N. American continent, two species are found in E. Siberia and China.

Catostomus commersoni (white sucker) *See* Catostomidae.

catshark *See* Scyliorhinidae.

cat's tail 1 (*Acalypha hispida*) *See Acalypha*. 2 *See* Typhaceae.

cattle *See* Pecora; and Bovidae.

cattle plague *See* rinderpest.

cattle-tick fever *See* red-water fever.

caudal fin Tail-fin of fish, used for steering, balancing, or locomotion.

caudal furca In some Crustacea, a forked extension of the telson.

caudal gill *See* tracheal gill.

caudal peduncle Tail region of the body of a fish, located between the anal and tail fins.

cauldron-subsidence Collapse of a volcanic crater due to the evacuation of a large magma chamber, or cauldron, and marked by a ring fracture, or ring-dyke. There are many examples of cauldron-subsidence, although the various mechanisms of their formation are not necessarily identical.

caulescent Becoming stalked.

cauliflorous Borne on the trunk.

Caulobacter Genus of Gram-negative bacteria not assigned to any taxonomic family. The cells undergo a life cycle that is unusual in bacteria. Mature cells are straight or curved rods with a stalk-like extension at one end. The cell is attached to rocks, plants, other cells, etc. by means of an adhesive holdfast at the tip of the stalk. Asymmetric division of a mature cell leads to the formation of a motile (flagellated) immature cell; this subsequently attaches to a substrate, loses its flagellum, and develops a stalk, thus becoming a mature cell. Species belonging to the genus *Caulobacter* are aerobic chemo-organotrophs. There are several species, found in soil, fresh water, and sea water.

Caulolatilus princeps (ocean whitefish) *See* Malacanthidae.

cave cricket *See* Rhaphidophoridae.

cave fish *See* Amblyopsidae.

cavernicolous Cave-dwelling.

cave salamander *See Proteus anguinus*.

caviar *See* Acipenseridae; and Cyclopteridae.

Caviidae (order Rodentia, suborder Hystricomorpha) Family of ground-dwelling rodents in which the body is sturdy, and in which there are four digits on the forelimbs, and three on the hind limbs. The tail is vestigial. The cheek teeth are hypsodont. The Caviidae are distributed widely in S. America. There are twelve species in five genera, including *Cavia* (guinea pigs) and *Dolichotis* (Patagonian hares).

caviomorph Applied to rodents of the family Caviidae.

cay Small, flat marine island formed from coral-reef material, or sand. The term is applied, for example, to the low-lying, sparsely vegetated islands off the coast of S. Florida, USA.

cayenne pepper *See Capsicum*.

CCD *See* carbonate compensation depth.

CCL *See* convective-condensation level.

^{14}C dating *See* radio-carbon dating.

ceará rubber *See Manihot*.

Cebidae (order Primates, suborder Anthropoidea, superfamily Ceboidea) Family that comprises the New World monkeys. They lack cheek pouches, and the nostrils are separated, and face laterally. The gait is quadrupedal but some use a form of brachiation. Some have prehensile tails. The family includes *Aotus* species (night monkey, owl monkey, and douroucoulis monkey) which are nocturnal. They have eyes with pure rod retinas, and lack prehensile tails. They may be closer than any other monkeys to the ancestral anthropoid form. Capuchin monkeys (several *Cebus* species) dwell in the forest canopy, feed on fruit and insects, and have an elaborate social structure. Howler monkeys (*Alouatta* species) feed on leaves and often move by swinging from the arms or tail. Spider monkeys (*Ateles* species) sometimes move by a form of brachiation, using long swings and jumps. They

dwell in the canopy in small or large troops, and feed on fruit and nuts. Cebids are found throughout the tropical S. American forests. There are 11 genera, with about 29 species.

Ceboidea (New World monkeys; order Primates, suborder Anthropoidea) Superfamily which comprises the families Callitrichidae and Cebidae. Isolated probably since the Eocene, the ceboids show certain differences from the Old World monkeys. Their noses are flat, the nostrils facing laterally (platyrrhine) due to ceboids' possession of a larger nasal apparatus than Old World forms. Facial vibrissae are present but are usually small. The tympanic bone forms a ring fused with the petrosal, and the bulla is large. The second premolar tooth is retained. Social organization is elaborate. Communication is mainly vocal, in some genera (e.g. *Alouatta*) incorporating distinct sounds each of which has a precise meaning. All species are fully arboreal, some possessing prehensile tails with ridged tail pads used as tactile sense organs and linked to a large area in the cerebral cortex, but the thumb is not fully opposable in any species.

Cebus (capuchin monkey) *See* Cebidae.

CEC *See* cation-exchange capacity.

cecidium (pl. cecidia) Plant gall.

cecidization Formation of a plant gall.

Cecidomyidae (gall midges, gall gnat; class Insecta, order Diptera, suborder Nematocera) Large family of nematoceran flies, all of which are minute and delicate, with long, monofiliform antennae with obvious whorls of hair. Ocelli may be present or absent. The wings have few longitudinal veins, most of which are unbranched. The antennae and wings are good points of recognition. There are three types of larval habit: parasitism, saprophagy, and phytophagy. Some cecidomyids form galls on plants that they attack. Some show pupal paedogenesis (larvae are produced from the pupal state). Many are considered to be serious pests, as their larvae are often phytophagous. Examples are *Mayetiola destructor* (hessian fly), a pest of wheat, and *Contarinia pyrivora* (pear midge), a pest of pears. More than 4000 species have been described.

Cecropia (family Urticaceae) Genus of fast-growing, small trees in which the wood is very light, and the young stems hollow. Many have symbiotic ants. There are 100 species, found in secondary forest in tropical America.

cedar apple Gall formed on certain conifer trees infected with the rust fungus *Gymnosporangium juniperi-virginianae*.

cedars 1 *See Cedrus*. 2 (Australia cedar, Burma cedar) *See Toona*. 3 (E. African pencil cedar) *See Juniperus procera*. 4 (incense cedars) *See Libocedrus*.

Cedrela (family Meliaceae) Genus of deciduous trees in which the leaves are pinnate. The flowers have a columnar disc to which the petals and stamens are adnate. The fruit is a small capsule. The trees yield valuable timber, closely related to *Toona*. There are five poorly-defined species, occurring from Mexico and the Caribbean region to Argentina.

Cedrus (cedars; family Pinaceae) Genus of elegant, evergreen conifers, which are large trees with valuable timber, and often planted for ornament. The needles are clustered on short shoots. There are four species: *C. libani*, the cedar of Lebanon; *C. atlantica*, Atlantic (or Atlas) cedar; *C. brevifolia*, the Cyprus cedar; and *C. deodara*, the deodar of the Himalayas.

Ceiba (family Bombacaceae) Genus of trees whose seeds are enveloped in silky hairs. *C. pentandra* (kapok), naturalized in W. Africa and planted widely in Asia, is one of the tallest trees of the Amazon rain forests. There are 10 species, occurring in tropical America.

Celastraceae Family of trees and shrubs in which the leaves are simple, and opposite, or alternate. The flowers are small, regular, and tri- or pentamerous, usually with a disc; and the ovary is superior. The fruits take various forms. The seed commonly has a vivid aril. *Euonymus europaeus* is the spindle tree or 'burning bush' of Britain. There are 90 genera, with 1000 species, with a cosmopolitan distribution, except for the Arctic and Antarctic.

Celastrophyllum circinerve One of the earliest flowering plants known to palaeobotanists. Flowering plants of the family Celastraceae pre-date most others. They began with *C. circinerve* in the Early Cretaceous, and survive today in the form of *Euonymus europaeus*, the spindle tree, or 'burning bush'.

celerity Velocity with which a wave advances. The celerity of an ideal wave is related to the wavelength and frequency by the wave equation $C = f\lambda$, where λ is the wavelength and f is n/t (the wave frequency: n is the number of waves passing a point per unit time, t).

celery (*Apium graveolens*) *See Apium*.

celery pine *See Phyllocladus*.

celestite Mineral, specific gravity 3.9–4.0, hardness 3.0–3.5, chemical composition $SrSO_4$, whose name, derived from Latin, alludes to its pale-blue colour. It occurs in sedimentary rocks, particularly dolomites, and as a cavity-lining association with barite, gypsum, anhydrite, and halite; and with gypsum and anhydrite in evaporite deposits. It can occur as a gangue mineral in hydrothermal veins with galena and sphalerite, and it will form concretionary masses in clays and marls. It is distinguished by its blue colour and high specific gravity. It is faint blue to colourless, sometimes stained red, and has a white streak and a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are normally very tabular, resembling barite, but they can also be fibrous and granular. It is a main ore mineral for strontium and strontium compounds.

cell 1 The fundamental autonomous unit of plant and animal bodies, consisting of, at least, a cell membrane containing cytoplasm and nuclear material, but often having a more complex structure. Simple organisms are unicellular, but more complex organisms consist of many co-operating cells. Characteristically, in plants, but not

in animals, cells are surrounded by a polysaccharide wall. 2 *See* mass provisioning.

cellar fungus Common name for *Coniophora puteana* (*C. cerebella*), which is a frequent cause of timber decay in damp buildings.

cell culture Mass of cells derived either from a single cell, or from a small group of cells from the same tissue or organ, that is maintained *in vitro* using solid or liquid nutrient media.

cell differentiation Process by which descendants of a single cell produce structural and functional specializations and maintain these during the course of the life of that individual. Specializations arise during early development of the individual by differential DNA–RNA transcription; within a species, particular cells differentiate into particular forms, each with their own functions.

cell fusion Experimental fusion of nuclei and cytoplasm from different somatic cells to form a single hybrid cell. Cells used for fusion often come from tissue cultures derived from different species: fusion is facilitated by the modification of the surface of cells by adsorption of certain viruses, e.g. Sendai virus.

cell growth Irreversible increase in the size of a cell: it can be caused by a change in the osmotic potential within the cell, or by a reduction of the pressure exerted by the cell wall.

cell line Lineage or pedigree of cells related through asexual division. The cell line of an organ traces the course taken by cell division from a single-celled zygote to the formation of that particular multicellular organ. A cell line may also be derived in the laboratory from a primary culture.

cell membrane (plasmalemma, plasma membrane) The sheet-like membrane, 7.5–10 nm thick, that encloses and delimits the contents of a cell. It is a living structure consisting of lipid molecules in a fluid bi-layer, and associated protein. Water molecules can pass freely through this structure, but the passage of most other molecules can be controlled. It may also have other functions, as in prokaryotic cells, where it is associated with oxidative metabolism and cell division.

cell plate Partition formed between daughter cells during cytokinesis in plant cells. It is a membrane pieced together from fragments which line up along the mid-plane of the spindle and then fuse from the centre outwards. Subsequently this forms the framework for new cell walls.

cell sap The contents of the large vacuole often found in plant cells.

cell theory Basic theory (proposed by Schleiden and Schwann in 1838) that all animals and plants are made up of cells, and that growth and reproduction are due to division of cells.

cellular slime moulds Slime moulds in which the feeding stage consists of independent cells (myxamoebae) that generally aggregate to form a pseudoplasmodium prior to fruiting.

cellulase Highly-specific endoglucosidase enzyme that catalyses the hydrolysis of cellulose into glucose by attacking beta-1,4 linkages.

cellulitis Inflammation of the skin and underlying tissues due to infection, via wounds, by pyogenic bacteria.

cellulolytic Able to break down or digest cellulose.

cellulose Straight-chain, insoluble polysaccharide composed of glucose molecules linked by beta-1,4 glycosidic bonds. It is the principal structural material of plants, and as such is the most abundant organic compound in the world. It has also been found in certain sea squirts.

cellulytic Able to break open (lyse) cells.

cell wall 1 (of eukaryote) Strong, often rigid, extraprotoplasmic layer in plant cells, whose growth is directed from within the cell. In addition to water, which may comprise by weight up to 70% of the wall, it consists of a variety of polysaccharides, notably celluloses, hemicelluloses and pectins, as well as variable (but smaller) amounts of proteins, lipids, lignins, tannins and even mineral salts. Cell walls provide a skeletal support to the whole plant and also a barrier against injury and infection. 2 (of prokaryote) Rigid wall structure that lies inside the capsular layer, but outside the plasma membrane of cells. In cyanobacteria it is composed primarily of cellulose, but in bacteria it is composed of a mixture of materials not found elsewhere. Gram-positive bacteria have relatively thick walls (15–80 nm) composed principally of peptidoglycans (40–90%), techoic acids, and other complex polysaccharides, with little sign of differentiation into separate layers. Gram-negative bacteria have much thinner walls (10 nm) composed of several distinct layers which are chemically different from those of Gram-positive species. Peptidoglycans represent only 1–10% of the wall material by weight; techoic acids are absent, but complex lipopolysaccharides are present.

Celosia cristata (cockscomb) *See* Amaranthaceae.

Celtis (family Ulmaceae) Genus of trees in which the fruit is a drupe. They yield useful timber, and in India their foliage is used for browse. There are 80 species, occurring mainly in the northern hemisphere, and extending to the Old World tropics.

cement 1 Bone-like substance which coats the surface of that part of a tooth embedded in the jaw and which sometimes coats the enamel of the exposed part of the tooth. 2 Material, e.g. calcite, that fills open pore space in fragmental and organic sediments.

cementation Process by which sedimentary rock particles or fragments are cemented together after deposition. Cementing materials are deposited from the mineral-rich waters that percolate through the open pore space of the rock. The percentage of cement depends on the amount of pore space and on the mud content within a given rock.

cemented Applied to massive, in-filled, and indurated mineral soil: such soil has a hard and

often brittle consistency because soil particles are joined together by cementing substances, e.g. calcium carbonate, silica, iron and aluminium oxide, or humus. Cemented soil usually appears as a highly distinctive and resistant horizon. *Compare* cement; and cementation.

Cenchrus (family Graminae) Genus of herbaceous plants, medium in height, variable in habit, and with culms that are not tuberous. They are widespread in the tropics and subtropics. Two species are endemic to Australia, one other is native, and seven are naturalized.

Cenomanian One of the stages of the Upper Cretaceous Period in Europe.

Cenozoic (Cainozoic) Era of geological time that began 65 million years ago. It includes the Tertiary and Quaternary Periods: the so-called ages of mammals and man. Molluscs and microfossils are used in the stratigraphic subdivision of the era. The Alpine orogeny reached its climax during this period of geological time.

Central Australian floral region Part of Good's (1974) Australian kingdom, which accounts for most of the Australian continent, including all the central parts. The flora is imperfectly known, although the great majority of it is likely to be endemic. Ecologically it coincides with extensive thorn forest, with much *Acacia aneura* (mulga), *A. harpophylla* (brigalow), and *Eucalyptus hemiphloia* (mallee). The flora is poor, partly because of the extensive deserts and semi-deserts that account for most of the region, and partly because central Australia was submerged for much of the Tertiary Period.

central limit theorem Theorem stating that the arithmetic mean values for a series of similar-sized, fairly large samples ($n > 30$) taken from a large population will be approximately normally distributed about the true population mean (μ), irrespective of the actual distribution pattern of the individual counts.

Centranthus (spurred valerian) *See* Valerianaceae.

Centrarchidae (sunfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Fairly large family of freshwater fish. The first of the two united dorsal fins is strongly spined, the scales feel rough because of the comb-like edges, the tail is broad (deep), and the tail-fin is slightly emarginate. The smaller representatives of the family, e.g. *Elassoma zonatum* (banded pygmy sunfish), make good aquarium fish. Larger species, e.g. *Micropterus salmoides* (largemouth bass) may reach a weight of 8 kg. *M. salmoides* is one of the sunfish species introduced into certain European rivers. Sunfish as a group are very popular with American amateur fishermen, the most popular species being *Lepomis macrochirus* (bluegill). There are about 30 species, all found in the eastern half of N. America.

centre of origin Part of the world, characteristically in the tropics, that exhibits marked diversity within a given taxon, particularly of the more primitive members of the taxon, and is often regarded as the centre of origin of that taxon. For example, there are six genera of Palmae (palms) in the lower part of the Amazon basin, twice the number found anywhere else. It is difficult, however, to reconcile this explanation of centres of origin with the concept of allopatric speciation.

centric fusion Whole-arm fusion of chromosomes.

centrifuge Apparatus used for the separation of substances by the application of centrifugal force: this is generated by high-speed rotation of a vessel containing a fluid in which the substances are suspended but not dissolved. Separation occurs because different substances have different rates of sedimentation according to their molecular size and shape.

centriole Hollow, cylindrical structure, normally one of a pair lying, at right angles to one another, adjacent to the nuclear envelope in animal cells; and composed of nine sets of microtubules, each set arranged in triplets. Centrioles are thought to be organizers of microtubular structures in these cells, and during cell division a pair is found at each pole of the mitotic spindle.

Centris *See* Anthophoridae.

Centriscidae (razorfish, shrimpfish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Family of small, marine, tropical fish which often swim in a vertical, head-down position. The compressed, thin body is covered by a bony casing produced from modified scales. The ventral side is produced into a hard and sharp keel ('razor blade'). They have a long, tubular snout with a small mouth at the end of it, which is used to suck up minute organisms. At least four species occur in the Indo-Pacific region, *Centriscus aristatus* (smooth razorfish) reaching a length of up to 25 cm.

Centriscus aristatus (smooth razorfish) *See* Centriscidae.

Centroceratida (class Cephalopoda, subclass Nautiloidea) Order of generally evolute, gyroconic cephalopods in which the siphuncle is sub-central in position. Some forms are nautiliconic. Sutures are tri-lobed. The order ranges in age from Lower Devonian to Upper Jurassic.

centrodorsal *See* Comatulida.

Centrolenidae (class Amphibia, order Anura (Salientia), suborder Procoela) Small family of mainly arboreal frogs, which are probably closely related to the leptodactylids. The feet have pads, and extra-digital cartilaginous elements. The tibia, fibula, and calcaneum are all fused. The pectoral girdle is arciferous. There are 40 species, occurring in Mexico and S. America.

Centrolepidaceae Family of tufted or cushion-like herbs with bristle-like leaves, similar to grasses, rushes, or mosses. They may be annual or perennial. The inflorescence is terminal and in a spike, with one or more pseudanthia consisting of one or two male flowers and two or more female flowers. The female flowers have a unilocular ovary, one style, and one ovule. The fruit has a membranous pericarp and dehisces by a longitudinal split. There is one seed in the locule; it has a

large endosperm. Two tribes are recognized within the family, the Trithurieae and Centrolepideae; and the most closely-related family is the Restionaceae. There are seven genera, with 40 species, found mainly in Australia and New Zealand, but extending to SE Asia and S. America. The family shows antarctic affinities.

Centrolepideae *See* Centrolepidaceae.

Centrolophidae (trevalla, ruffe; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of medium-sized to large marine fish, with long anal and dorsal fins, fairly small pelvic fins, and a slightly forked tail-fin. The few spines of the dorsal fin may be absent or short, or grade into the many-rayed, soft second dorsal. Centrolophids tend to be pelagic fish, living near the edge of the continental shelf in temperate waters. *Centrolophus niger* (blackfish or black ruffe) occurs in the N. Atlantic. Among those living in the southern hemisphere are *Hyperoglyphe porosa* (deep-sea trevalla) and the warehou (a name thought to be of Maori origin), *Seriolella brama*. Both species are caught regularly by trawlers in E. Australia and New Zealand. There are about 22 species.

Centrolophus niger (blackfish, black ruffe) *See* Centrolophidae.

centromere The point at which the two halves of a chromosome, the chromatids, are joined. *See* kinetochore; and spindle attachment.

Centropomidae (Ambassidae; perchlet, snook; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of basically marine fish, but with representatives living either in brackish or fresh water, with a wide range in size. All tend to have two separate dorsal fins, strong spines in the first dorsal and anal fins, and a lateral line extending on to the tail. The smaller species have large eyes and a forked tail. *Chanda ranga* (Indian glass fish) and *Ambassis elongatus* (yellowfin perchlet), found in N. Australian rivers, grow no larger than 5 cm. *Centropomus undecimalis* (snook) of the W. Atlantic, and *Lates calcarifer* (giant perch) found in estuaries of N. Australia, may grow to a length of 1.5 m. Both species are sought by fishermen. There are about 30 species.

Centropomus undecimalis (snook) *See* Centropomidae.

Centropus (coucals; family Cuculidae) Genus of short-winged, long-tailed, medium- to large-sized cuckoos, with heavy hooked bills. They are mainly terrestrial and insectivorous and are found in forests and scrub, building an enclosed nest with a side entrance, close to the ground. There are 27 species found in Africa, S. Asia, and Australasia.

centrosome In a cell, the distinct part of the cytoplasm that contains the centriole.

centrum The massive part of a vertebra, lying to the ventral side of the spinal cord.

century plant (*Agave americana*) *See Agave*.

cep Common name for the fruit body of *Boletus edulis*, an edible and highly esteemed bolete often marketed in parts of Europe. It is used commercially as an ingredient of dried 'mushroom' soup.

Cepaea Genus of snails, including *C. hortensis* and *C. nemoralis*, that show visible polymorphism for banding, shell colour, and shell height. They have formed the subject of extensive studies in ecological genetics, where it has been shown that different selective processes relating to various factors, including differential predation and differential response to sunlight, are responsible for the maintenance of the different morphs in the population.

Cephalaspidea (Bullomorpha; phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods in which the mantle cavity is reasonably well developed. The bubble-shaped shell is internal and very small in some genera. A wide foot and head shield are present. All are hermaphrodites.

Cephalaspidiformes (class Cephalaspidomorphi) Order of fish-like, fossil vertebrates which lived during the late Silurian-Devonian Period. They had somewhat flattened bodies, with a broad head, ten pairs of ventral gill openings, a ventral jawless mouth, a heterocercal tail, and a single median nostril communicating with a blind-ending naso-hypophysial pouch. The dorsally-located eyes and flat belly suggest a bottom-dwelling way of life. Together with the still-living lampreys (order Petromyzoniformes) they have been placed recently in the class Cephalaspidomorphi, although other classifications have also been made.

Cephalaspidomorpha Superorder of jawless vertebrates including the order Petromyzoniformes (lampreys).

Cephalaspidomorphi Class of jawless fish-like animals including the extant lampreys and their fossil relatives.

Cephalaspis *See* Agnatha.

Cephaleuros (family Trentepohliaceae) Genus ot parasitic algae that grow beneath the leaf cuticles of a host plant. They are responsible for the disease 'red rust' of tea and other plants.

cephalin Group of phospholipid compounds, which includes phosphatidyl ethanolamine and phosphatidyl serine. Both are major phosphoglycerides in animals and higher plants, in which they are important constituents of membranes.

Cephalocarida (phylum Arthropoda, subphylum Crustacea) The most primitive class of crustaceans, first described in 1955, cephalocarids are small, shrimp-like crustaceans, all less than 4 mm long. The body comprises a semicircular head and a long trunk of 19 segments, of which only the anterior nine bear limbs. Eyes are absent and both pairs of antennae are short. All the trunk limbs are similar, and they resemble the second pair of maxillae. They are unusual in that each bears an outer lobe or pseudopipodite, which gives the limb a triramous rather than biramous structure. Cephalocarids are hermaphroditic, and live in bottom silts which they filter for organic matter. The class comprises four genera, with seven species, and has been found in coastal waters off eastern and western N. America, the W. Indies, and New Zealand.

Cephalochordata (Acrania) Subphylum of Chordata, containing only *Amphioxus* (lancelet), probably the most primitive of living chordates, although some soft-bodied Cambrian fossils are dubiously referred to the group. Cephalochordates have a notochord extending into the head, gill slits, and segmented muscle blocks, and are thought to resemble the ancestors of vertebrates. *See also* Branchiostomidae.

Cephalodiscida (class Pterobranchia) Order of free, unattached associations of individual zooids. The mesosoma bears several pairs of arms. The gonads are paired, with a pair of gonadial openings. There is one pair of branchial pores. The skeleton (coenoecium) is very variable and usually irregular in form. Their first known occurrence is in the Lower Ordovician.

cephalodium Specialized region in a lichen thallus in which occur cyanobacteria (blue-green algae) that are capable of carrying out nitrogen fixation. Lichens that have cephalodia have a green phycobiont (i.e. a member of the Chlorophyta) in the remainder of the thallus.

cephalon *See* Trilobitomorpha.

Cephalopoda Literally 'head-foot', a class of Mollusca, exclusively marine, related to the Bivalvia and Gastropoda. The class includes the Nautiloidea (nautiloids), Sepioidea (cuttlefish), Tenthoidea (squids), Octopoida (octopuses), and the extinct Ammonoidea (goniatites, ceratites, ammonites), and Belemnoidea (belemnites). The earliest forms belonged to the Nautiloidea and date from the Upper Cambrian.

Cephalosporium (class Hyphomycetes) Form-genus of fungi which form septate mycelia and which produce conidia in phialids. Some species produce antibiotics called cephalosporins.

Cephalotaxaceae (cow's tail pines) Family of the Gymnospermae, close to the Taxaceae, consisting of small trees with narrow, pinnately arranged, yew-like foliage. They are dioecious, like the yews. The male cones are small, and globular to oval. The female flowers usually occur as two pairs, or in bunches of 3–5, on curved stalks at the shoot bases, and produce olive-like 'fruits' which are erect and which have a fleshy aril enclosing the seed (except at its tip). They are cultivated as ornamental trees. There is one genus (*Cephalotaxus*), with seven species, which occur in SE Asia.

cephalothorax In some members of the phylum Arthropoda, the fused head and thorax. It is found in members of the subphylum Chelicerata (classes Merostomata, Arachnida, and Pycnogonida), and in most Crustacea (subphylum Mandibulata). In spiders, it is the prosoma, which is covered by a sclerotized plate (carapace), and which bears the walking limbs, pedipalps, chelicerae, and eyes. The opisthosoma (abdomen) is joined to the cephalothorax by a stalk (pedicel).

Cephalotus (family Cephalotaceae) Genus consisting of one species, *C. follicularis*, native to the peat bogs of W. Australia. It is a perennial herb with a woody rhizome, and its leaves form a rosette. Many of the leaves are modified as insect-catching, lidded pitchers (resembling *Nepenthes*). The flowers are small, their parts in sixes, apetalous, and borne on a long scape. Perhaps they are related to Saxifragaceae.

Cephalozi (order Jungermanniales) Genus of leafy liverworts. *C. bicuspidata* is a very common species. It is very small, with thread-like stems bearing two ranks of pale green leaves; each leaf is deeply divided into two pointed lobes. Flagella may be present. It is found in wet acidic habitats, including banks, woodland paths, *Sphagnum* bogs, etc.

Cephidae (suborder Symphyta, superfamily Cephoidea) Small family of stem-boring symphytans the adults of which are 9–13 mm long, usually black, and with a laterally slightly-flattened abdomen. The larvae tunnel into the stems of grasses and other plants. *Cephus pygmaeus* (the European wheat-stem sawfly) was introduced into N. America in the 1880s, where it has become a serious agricultural pest.

Cephus pygmaeus (wheat-stem sawfly) *See* Cephidae.

Cepolidae (bandfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of fairly-rarely encountered marine fish which are recognizable by their eel-like bodies, tapering towards the tail, and by the long dorsal and anal fins which are continuous with the tail-fin. Bandfish, with their reddish back and fins, can be found during trawling at depths of more than 100 m, but also occur closer inshore in the E. Atlantic, Indo-Pacific, and off Australia and New Zealand. There are about seven species.

Ceractinomorpha (phylum Porifera, class Demospongiae) Subclass of sponges which have parenchymular, incubated larvae. Either organic fibres or spicules may dominate the skeleton. The spongin fibres may contain detritus and spicules.

Cerambycidae (longicorn beetles, longhorn beetles, timber beetles; class Insecta, order Coleoptera) Family of elongate, pubescent beetles, usually strikingly marked, up to 20 cm long. The antennae are filiform, at least two-thirds of the body length, and often greater. Larvae are fleshy, elongate, with powerful jaws, and reduced legs. They feed on wood of dead or dying trees, and may take four years to reach maturity. *Hylotrupes bajulus* (house longhorn beetle) is a serious pest of structural timbers, particularly pine. *Aromia moschata* (musk beetle), feeds on willow. There are 20 000 species.

Ceramiales (class Rhodophyceae) Large order of red seaweeds, most of which have a delicate membranous or filamentous thallus. The order includes four families and more than 250 genera, and is distributed worldwide.

Cerapachyinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of ants that are sometimes classified as a tribe within the subfamily Ponerinae. They possess spines on the pygidium (the last visible gastral tergite), and short, thick antennae; and they lack dorsal thoracic sutures. They are predators of other ant species. There are about 200 species, found in the tropics.

Ceratias holboelli (deep-sea anglerfish) *See* bipolar distribution of fish.

Ceratiidae (deep-sea devil; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Family of short, thick-set, deep-sea fish, with a large mouth, minute eyes, and a long, fleshy 'lure' above the eyes. The much smaller males are attached to the females, remaining in a parasitic association.

Ceratina (carpenter bees) *See* Anthophoridae.

Ceratiomyxales (subclass Ceratiomyxomycetidae) Order of slime moulds containing a single genus: *Ceratiomyxa*. In *C. fruticulosa* the fruiting bodies are variable, but typically they are branched white columns 1–10 mm tall. *C. fruticulosa* is common and very widely distributed, being found from arctic to tropical regions. Two other species of *Ceratiomyxa* are found in tropical and subtropical regions.

Ceratiomyxomycetidae (class Myxomycetes) Subclass of slime moulds in which spores are borne externally on the surface of column-like fruiting structures. The subclass contains a single order: Ceratiomyxales.

ceratites *See* Ammonoidea.

Ceratocystis (family Ophiostomataceae) Genus of fungi which includes a number of important plant pathogens. *C. ulmi* is the causal agent of Dutch elm disease. Other species cause disease in oaks, sweet potatoes, coffee, rubber, and sugar-cane; and some can cause staining of timber.

Ceratodidae (Australian lungfish; class Osteichthyes, subclass Dipneusti, order Ceratodiformes) Monospecific family comprising the Australian lungfish which has a fairly compressed body with flipper-like pectoral and pelvic fins, and large scales. It occurs in a number of rivers in NE Australia. The lung-like air bladder can be used to utilize atmospheric oxygen.

Ceratodiformes (class Osteichthyes, subclass Dipneusti (Dipnoi), superorder Ceratodimorpha) Order comprising the one family Ceratodidae.

Ceratodimorpha Superorder of bony fish including the orders Ceratodiformes and Lepidosireniformes.

Ceratodon (order Dicranales) Genus of mosses in which the leaves are ovate to narrowly lanceolate with recurved margins. *C. purpureus* is very common in Britain. It grows on bare ground, forming extensive colonies which are particularly conspicuous in spring owing to the reddish-purple colour of the abundant capsule stalks (setae). It is found on heaths, moors, roadside banks, etc., and on wall tops. It is a cosmopolitan genus of about 22 species.

Ceratolobus (family Palmae) Genus of climbing palms (rattans) in which the stems are clustered, and in which the leaves have a spiny cirrus (whip-like tip), some of them with fishtail-shaped leaflets. They are dioecious. The inflorescence is entirely enclosed in a single, flattened bract with a slit-like opening. The fruits are scaly, and contain one seed with a thin fleshy testa. The cane is not used. There are six species, occurring in Sumatra, Malaya, Java, and Borneo.

Ceratomorpha (superorder Mesaxonia, order Perissodactyla) Suborder of mammals comprising the superfamilies Tapiroidea and Rhinocerotoidea, the fossil and recent Old and New World tapirs and rhinoceroses. They are perissodactyls in which the nasal bones are stout and projecting, the cheek teeth are low-crowned, and the limbs are short and thick, with three digits on the hind feet and three or four on the fore feet. Rhinoceroses, but never tapirs, may have horns.

Ceratophyllaceae (hornworts) A family of submerged, aquatic herbs, which have leaves in whorls of narrow, forked segments. The flowers are small, unisexual, sessile, and solitary in the leaf axils, with a tiny perianth of many narrow lobes. The male flowers have 10–20 stamens, the females a one-celled ovary forming a one-seeded nut. There is one genus (*Ceratophyllum*) and three species, cosmopolitan in distribution except for the Arctic.

Ceratopogonidae (biting midges; class Insecta, order Diptera, suborder Nematocera) Family of small to minute, gnat-like flies, in which the males have plumose antennae, the head is not concealed by the thorax, and ocelli are absent. The short mouthparts are of a piercing type. All adults of this family are predatory, sucking blood, or eating smaller insects. There are two types of larval habit. One group has aquatic, vermiform larvae, the other has terrestrial larvae which live under bark, or in decaying material. Adults of the genus *Culicoidea* will bite mammals, and can transmit certain blood-borne diseases. They are avid biters at sunset in certain parts of the Holarctic, and in some places are great pests. In the northern parts of the USA and Canada they are known as 'no-see-ums' on account of their small size and vicious bite. There are more than 500 described species. Their distribution is mainly Holarctic, but there are representatives throughout the world.

Ceratopsia Horned, ornithischian (bird-hipped) dinosaurs, which had beak-like jaws, from the Upper Cretaceous. The head accounted for about one-third of the total length of the body because of the development of a large, bony frill which protected the neck and shoulders. *Triceratops* is perhaps the best-known member of the group. It was 5–6 m long and had three forward-projecting horns, one over each eye, and the third over the nose.

Cerceris *See* leaf-cutter bee; and mason bee.

cerci In many insects, a pair of cylindrical or conical appendages at the posterior end of the abdomen, often serving a sensory function.

Cercidiphyllaceae (order Hamamelidales) Family of large, deciduous trees closely related to the Magnoliaceae. The leaves are simple, opposite or alternate, with stipules. The flowers are unisexual, with four perianth parts, and the plants are dioecious. The fruits are follicles. *Cercidiphyllum japonicum* (Katsura tree), over 30 m tall, is an important source of fine-grained timber, and produces striking yellow and orange autumn foliage. The family is native to Japan and China.

Cercidiphyllum japonicum (Katsura tree) *See* Cercidiphyllaceae.

Cercopidae (froghoppers, spittlebugs, cuckoo-spit insects; order Hemiptera, suborder Homoptera) Family of homopterans in which the nymphs of most species live on the shoots or roots of plants and produce a protective mass of froth around themselves. Adults of some species have several different colour forms, and some species are pests of crops or pasture plants. There are about 2500 species, distributed worldwide.

Cercopithecidae (Old World monkeys; order Primates, suborder Anthropoidea, superfamily Cercopithecoidea) Family comprising all existing Old World monkeys, possessing the characteristics of the superfamily. The family includes *Papio* (baboons), *Mandrillus* (mandrills), and *Cercopithecus* (guenons); and *Colobus* (guerezas) of Africa, *Macaca* (rhesus monkey and macaques), of Asia and Africa, and the langurs (e.g. *Presbytis entellus*, the entellus langur of India, and *Pygathrix nemaeus*, the douc langur of SE Asia) of Asia. *Nasalis larvatus* (proboscis monkey) of Borneo has the cercopithecid nose developed to an extreme, up to 17 cm long in adults. There are 8–20 genera, with about 60 species, distributed throughout Africa and Asia.

Cercopithecoidea (order Primates, suborder Anthropoidea) Superfamily which comprises the extinct and extant monkeys of the Old World. Most are larger than ceboids. Ischial callosities are present, often surrounded by brightly-coloured skin which becomes enlarged in females prior to ovulation. Cheek pouches are present and are used to transport food. The tail is never prehensile. The olfactory turbinals are reduced, the nostrils close together and pointing downward. The second premolar tooth is absent. Some species are ground-dwelling. Thumbs may be opposable. Cercopithecoids may be herbivorous or omnivorous.

Cercopithecus (guenon) *See* Cercopithecidae.

Cerdocyon thous (crab-eating fox) *See* Canidae.

cere In birds, an area of skin at the base of the upper mandible, surrounding the nostrils. It is found in Falconiformes, in which it is bare; in Psittaciformes, in which it is usually feathered and in Columbidae, in which it forms a swollen flap above the nostrils.

cerebellum The lobes of the hind brain formed by the outgrowth of the anterior end of the dorsal surface, and concerned mainly with the co-ordination of complex muscular activity.

cerebriform Resembling a brain; convoluted.

cerebroside Ceramide monosaccharide: it occurs most abundantly in the myelin sheath of nerves.

cerebrum Pair of hemispheres originating from the anterior end of the fore brain: in primitive vertebrates it is concerned mainly with the olfactory sense, but in mammals forming the largest part of the brain, with an increasingly convoluted cortex (grey matter), and concerned with the analysis of sensory information and the instigation of responses.

Ceriantharia (class Anthozoa) Small order of solitary, semi-burrowing sea-anemones, lacking a skeleton. Mesenteries are complete but unpaired. Tentacles are arranged in two rings, marginal and oral.

Ceriantipatharia (class Anthozoa) Subclass which includes the orders Antipatharia and Ceriantharia, on the basis of the very weak or indefinite musculature of the mesenteries, and the insertion of new mesenteries only in the dorsal intermesenterial space.

Cerioporina (class Gymnolaemata, order Cyclostomata) Suborder of bryozoans whose colonies are characteristically dense and thick, and either branching or in flattened, layered masses. Individuals possess closely-joined, cylindrical or prismatic tubes which are subdivided by horizontal diaphragms. The suborder occurs from the Triassic to Recent.

Ceroxylon (family Palmae) Genus of palms, in which the stem is solitary. They are the tallest of all palms, sometimes reaching 60 m, and some have waxy stems that shine white. The leaves are pinnate with an erect sheath; the inflorescences form among the leaves. The wax is of commercial value. They provide the official emblem of Colombia. There are 17 species, found in the Andes north from Lake Titicaca, to altitudes of more than 4000 m.

cerradão Variant of the campos savannahs of central Brazil. In fact they hardly qualify as savannah because the vegetation comprises an almost closed, semi-evergreen woodland.

Certhia (tree-creepers; family Certhiidae) Genus of small, brownish birds, streaked above and white below, with slightly-curved bills. They are short-winged, have long claws and stiff, pointed tail-feathers, and are weak fliers. They inhabit forests, nesting in crevices, and are insectivorous, foraging by climbing vertically up tree and rock surfaces. There are six species, found in N. America, Europe, and Asia.

Certhiidae (treecreepers; order Passeriformes) Family of one genus of birds, *Certhia*, with six species. The monotypic family Salpornithidae (spotted creeper) is sometimes included.

cerussite A mineral, specific gravity 6.4–6.6, hardness 3.0–3.5, chemical composition $PbCO_3$, whose name is derived from Latin and means 'white lead'. It is a mineral of secondary origin in the oxidized zone of lead veins, and is associated with anglesite, galena, smithsonite, pyromorphite, and sphalerite. It is distinguished by its high specific gravity, adamantine lustre, and its solubility (with effervescence) in warm, dilute nitric acid. It is usually white or grey, and has a white streak and an adamantine lustre. It crystallizes in the orthorhombic system. The crystals are often prismatic or tabular, also acicular; but they can also be granular, massive, and compact. It is an ore mineral of lead.

cervical vertebra One of the vertebrae of the neck.

Cervidae (deer; order Artiodactyla, suborder Ruminantia, infra-order Pecora, superfamily Cervoidea) Family of browsing or grazing animals,

which appeared in Eurasia in Miocene and early Pliocene times and which radiated widely by the end of the Pliocene. Some of the later Pleistocene representatives, e.g. *Megaloceros giganteus* (the Irish elk), were giant types, much larger than the surviving forms. The horns (antlers) are complex in many species but simple in ancestral and some primitive species; usually they are present only in the male (but in *Rangifer* they are present in both sexes). Usually they are shed annually. Ancestral and some modern species (e.g. *Moschus*) have canine tusks. The feet have four digits. Most species (but not all) are gregarious, living in herds with elaborate social organization. They have a Holarctic distribution. There are about 16 genera, and 43 species, including *Cervus* (red deer and wapiti or American elk are included in *C. elaphus*), *Rangifer* (reindeer or caribou is *R. tarandus*), *Alces* (European elk and American moose are both *A. alces*), *Capreolus* (roe deer), *Dama* (fallow deer), and *Muntiacus* (muntjacs). *Moschus* (musk deer) nowadays is often referred to a separate family, Moschidae.

Cervoidea (superorder Paraxonia, order Artiodactyla, infraorder Pecora) Superfamily comprising the ancestral deer and their modern descendants, the families Cervidae and Giraffidae.

Cervus (red deer, wapiti, American elk) *See* Cervidae.

Ceryle (kingfishers; family Alcedinidae) Genus of large, crested, blue-grey or black and white kingfishers with long, heavy bills. They are found by streams and ponds, nesting in holes in banks and feeding mainly on fish. There are five species found in N., C., and S. America, Africa, and Asia.

Cestida *See* Cestidea.

Cestidea (Cestida; class Tentaculata) Order of ctenophorids which have greatly compressed bodies. Some forms may be up to 1.5 m long. There are two main tentacles, and smaller tentacles surround the anterior edge.

Cestoda (tapeworms; phylum Platyhelminthes) Class of parasitic, platyhelminth worms all of which lack a gut. The genitalia are normally repeated. The majority of forms possess a scolex which may have suckers. Mature individuals lack cilia. All are endoparasitic, most mature individuals living within vertebrates.

Cetacea (whales; infraclass Eutheria, cohort Mutica) Order comprising the one extinct (Archaeoceti) and two extant (Odontoceti and Mysticeti) suborders of whales. The earliest whales (Archaeoceti) are known from Eocene rocks, especially in Africa, and probably are descended from a primitive carnivorous, or pre-carnivorous, group. Of the two existing groups of whales, the Odontoceti (toothed whales) can be traced back to ancestral forms in the Upper Eocene, while the first definitive Mysticeti (baleen whales) occur in Oligocene strata. Whales are streamlined, almost hairless, entirely aquatic. The forelimbs are modified to form paddles without visible digits, the hind limbs are absent, the pelvis is vestigial. The tail-fin is horizontal and used for propulsion. The skull is modified, with the nasal openings far back on the dorsal surface except in Physeteridae. The diet comprises fish (Odontoceti) or plankton (Mysticeti).

Cetomimidae (flabby whalefish; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of marine, oceanic fish with naked skin, rudimentary eyes, and lacking pelvic fins. There are about 10 species.

Cetopsidae (whale catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Small family of freshwater catfish with a scaleless body, three pairs of barbels around the mouth, small eves, a small single dorsal and no adipose fin, and a low anal fin. There are about 12 species, found in S. America.

Cetorhinus maximus (basking shark) *See* Lamnidae.

Cetraria (family Parmeliaceae) Genus of lichens in which the thallus is foliose to more-or-less fruticose with erect, flattened branches. Rhizines, when present, occur on the lower surface, and are confined to the central portion of the thallus. Apothecia are lecanorine and occur at or near the edges of the thallus. The spores are colourless, and aseptate. They are found on the ground, on trees, on rocks, etc., according to species. *See also* Iceland moss.

Cettia (bush warblers; family Sylviidae) Genus of brown, soft-feathered, skulking warblers with only 10 tail feathers. They have loud, distinctive songs, and inhabit forest undergrowth and scrub, often near water, nesting in a bush or on the ground and feeding on insects. There are 11 species, found in Europe, N. Africa, S. Asia, Indonesia, and the Philippines.

Ceyx (kingfishers; family Alcedinidae) Genus of very small blue or red kingfishers with red bills and three-toed syndactylous feet. They are found by lakes and rivers, nesting in holes and feeding on insects and fish. There are 11 species, found in S. Asia, the Philippines, Indonesia, Papua New Guinea, the Solomon Islands, and Australia.

chachalacas *See* Cracidae; and *Ortalis*.

chacoan peccary (*Catagonus wagneri*) *See* Tayassuidae.

Chaenomeles (japonica; family Rosaceae) Genus of small trees, close to quince (*Cydonia*) and to apple (*Malus*) but with many seeds per fruit cell, scarlet flowers in clusters, thorns on twigs, and globose, yellow, downy fruits. There is one species in cultivation, *C. speciosa*, from China.

Chaetodermatida (class Amphineura, subclass Aplacophora) Order of aplacophorans which lack a ventral groove. The simple, bell-shaped mantle cavity contains a pair of, or several, true gills. Individuals are unisexual. They are Recent in age.

Chaetodon capistratus (foureye butterfly fish) *See* Chaetodontidae.

Chaetodontidae (butterfly fish, angelfish; class Osteichthyes, subclass Actinopterygii) Large family of marine, deep-bodied, and almost discus-shaped

fish. They have a small, protractile mouth; minute teeth on the jaws; a single, continuous dorsal fin with scales along the base; and a round to emarginate tail-fin. The family includes numerous beautiful, brightly-coloured species, which are very popular among seawater aquarium hobbyists. Among the more widely distributed butterfly fish are *Chaetodon capistratus* (foureye butterfly fish) of the W. Atlantic, and *Chaetodon vagabundus* (vagabond butterfly fish) of the Indo-Pacific and N. Australia. Angelfish, e.g. *Pomacanthus imperator* (emperor angelfish) of the Indo-Pacific, have a characteristic spine at the angle of the pre-opercle (part of the gill cover), and are often placed in a separate family, the Pomacanthidae.

Chaetodon vagabundus (vagabond butterfly fish) *See* Chaetodontidae.

Chaetognatha Phylum comprising the 'arrow worms', first encountered in the fossil record in Carboniferous rocks.

Chaetonotoida (phylum Aschelminthes, class Gastrotricha) Order of microscopic, aschelminth worms in which the male genitalia are always lacking. Most inhabit freshwater habitats.

Chaetorhynchus papuensis (Papuan mountain drongo) *See* Dicruridae.

chaetotaxy (setation, trichiation) The arrangement of hairs on the body of an insect, which is often used as a taxonomic guide.

Chaetura (swifts; family Apodidae) Genus of small bluish-black or brown swifts, with paler throats or rumps, and spine-tipped tails. They are aerial, nesting in hollow trees and chimneys, and feeding on insects. There are eight species found in N., C., and S. America. Many authorities include the genera *Hirundapus*, *Raphidura*, *Telacanthura*, and *Zoonavena* within this genus.

chafer *See* Scarabaeidae.

chaffinches *See Fringilla*.

Chagas's disease Disease which can affect humans and other animals. It occurs chiefly in C. and S. America. The causal agent is a protozoon, *Trypanosoma cruzi*. The pathogen is transmitted by blood-sucking bugs. Symptoms may include anaemia and various signs of heart, gland, and nervous-system involvement. The disease is named after the Brazilian physician Carlos Chagas.

chain lightning *See* pearl necklace lightning.

chain response (ethol.) Sequence of behaviour in which each item produces a situation that evokes the next, e.g. in courtship rituals the correct response of one partner is likely to evoke the next behaviour in the other.

chalaza Base of an ovule, bearing an embryo sac surrounded by integuments.

chalcedony Variety of quartz which occurs fibrous to cryptocrystalline, and stalactitic and botryoidal. It is white, grey-white, grey, or bluish-grey, and sometimes yellowish. *See also* chert.

Chalcidae (chalcid wasps; suborder Apocrita, superfamily Chalcidoidea) Family of fairly common wasps most of which are 2–7 mm long, generally uniformly dark in colour, and with greatly enlarged hind coxae and femora. The femora are often toothed ventrally. The wings are not folded longitudinally at rest, and the ovipositor is short. Members of the family are larval parasites of Lepidoptera, pupal parasites of Diptera, and some are egg parasites of cockroaches. When disturbed, chalcids often roll up and feign death.

Chalcidoidea (chalcid wasps; order Hymenoptera, suborder Apocrita) Very large superfamily of mostly small to minute, parasitic (sometimes phytophagous) wasps which occur almost everywhere and have very diverse forms and habits. Adults are 0.2–30 mm long, the majority being 1–3 mm. Wing venation is greatly reduced, the pronotum squarish, the antennae elbowed and usually short, and the ovipositor short. Adults are usually black, blue-black, or greenish, and many have a metallic sheen. The wings are normally held flat over the abdomen although some are brachypterus or apterous. The larvae may be parasitic, hyperparasitic, or phytophagous, and many species exhibit polyembryony (one egg gives rise to many individuals by the division of the embryo). Many chalcidoid species have a modified middle leg and can jump with agility. The complex classification and small size of the species makes the group particularly difficult for study by the beginner.

chalcid seed flies *See* Torymidae.

chalcid wasp Common name often given to any member of the superfamily Chalcidoidea, but applied strictly only to members of the family Chalcidae.

chalcopyrite (copper pyrites) Most common copper mineral, specific gravity 4.1–4.3, hardness 3.5–4.0, chemical composition $CuFS_2$. It is a primary mineral found in igneous rocks and hydrothermal veins, in association with pyrite, pyrrhotine, cassiterite, sphalerite, galena, quartz, and calcite. It is an important mineral in porphyry copper deposits, and also occurs in quartz diorite, and in pegmatites, crystalline schists, and contact metamorphic zones. Its colour is deeper than that of pyrite, it is more brittle and harder than gold, it is soluble in nitric acid, and its alteration products are secondary copper minerals. It is brass-yellow, often with an iridescent tarnish, and it has a greenish-black streak and a metallic lustre. It crystallizes in the tetragonal system. The crystals are usually tetrahedra, but they can be massive. It is a major copper mineral ore.

chalcosite (copper glance) Mineral, specific gravity 5.5–5.8, hardness 2.5–3.0, chemical composition Cu_2S, whose name is derived from the Greek for 'copper'. It can occur in hydrothermal veins in a primary state, but is more usually found in the zones of secondary enrichment of copper-ore bodies, in the lower parts of the oxidation zone. It is distinguished by its black colour, solubility in nitric acid, association with other copper minerals, and its alteration to secondary copper minerals. It is dark lead-grey tarnishing to black, and has a black streak and a metallic lustre. It crystallizes in

the orthorhombic system. The prismatic and tabular crystals are rare, and it is usually found massive, or as powdery coatings. It is an ore mineral for copper.

Chalicodoma *See* leaf-cutter bee; and mason bee.

Chalicotheriidae (class Mammalia, order Perissodactyla) Suborder of Perissodactyla that lived from the Eocene onward in Europe and N. America, and survived until the Pleistocene in Africa. *Moropus*, which might be taken as a representative of the group, must have resembled a clawed horse whose front legs were slightly longer than the back legs. These animals may have used their claws to bend down leafy branches, but more probably they were employed in excavating roots and tubers. *See* Ancylopoda.

chalk Porous, fine-grained rock, predominantly composed of the calcareous skeletons of microorganisms, e.g. coccolithophores and foraminifera. The Chalk Formations of the Upper Cretaceous of Europe form the White Cliffs of Dover and the cliffs south of Calais.

chalone Tissue-specific protein of moderate size, or a simple polypeptide that in the presence of adrenalin inhibits mitosis in cells. The loss of chalones from damaged cells stimulates and directs wound healing.

chalybeate Of natural waters, containing iron.

chalybite *See* siderite.

Chamaea fasciata (wren-tit) *See* Chamaeidae.

Chamaecyparis (family Cupressaceae) Genus of coniferous trees with adpressed, scale-like leaves in opposite pairs, foliage in flattened, dorsiventral sprays, and small cones. They are much cultivated and hybridized by humans as ornamental trees and hedging shrubs. There are six species, which occur in N. America, Japan, and Taiwan.

Chamaedorea (family Palmae) Genus of palms, most of which are small, delicate, shade-loving palms of forest undergrowth. Many are clump-forming. The stems are slender, hoop-marked, and erect, or rarely climbing. The leaves are small, pinnate, or simple. The plants are dioecious. Several are in cultivation as house plants. There are about 130 species, occurring in C. and S. America, and around the Caribbean.

Chamaeidae (wren-tit; order Passeriformes) Monotypic family, comprising *Chamaea fasciata*. This is a small, brown, long-tailed bird, inhabiting scrub, nesting in bushes, and feeding on insects and berries. It is often placed in the Timaliidae. It is found along the Pacific coast of N. America and N. Mexico.

Chamaeleo chamaeleon (common chameleon, European chameleon, Mediterranean chameleon; order Squamata, suborder Sauria (Lacertilia), family Chamaeleontidae) Species of lizard which basks on branches of trees and shrubs. Its protruding eyes can move independently. It has a prehensile tail. Basically it is greenish but it is able to change colour. It occurs in N. Africa, S. Spain, Crete, and SW Asia.

Chamaeleontidae (chamaeleons; order Squamata, suborder Sauria (Lacertilia)) Family of arboreal lizards, which are agamid descendants. The eyes are protruding, with the lids fused to a small central aperture, and they move independently. There is no tympanum. The tongue is sticky and may equal the body in length. Horns are common. The toes are grasping and opposable. The tail is prehensile. There are 86 species, all confined to the Old World, and found mainly in Africa and Madagascar. *See also Chamaeleo chamaeleon.*

chamaeophyte One of Raunkiaer's life-form categories, being a plant in which the perennating bud or shoot apices are borne very close to the ground. Four subcategories are recognized: (a) suffruticose chamaeophyte, in which the aerial shoots die back partially at the onset of unfavourable conditions and buds arise on the lower, persistent stem portions; (b) passive chamaeophyte, in which the aerial stems fall over as they die back, to give buds on horizontal axes near the ground; (c) active chamaeophyte, which also produces buds on horizontal stems, but as the more normal growth form of the plant; and (d) cushion chamaeophyte, which is essentially a compacted suffruticose chamaeophyte. *Compare* cryptophyte; hemicryptophyte; phanerophyte; and therophyte.

Chamaeropa (family Palmae) Monotypic genus, comprising *C. humilis*, one of Europe's two native palms. It has a short, stout trunk, and may be solitary or growing in clumps. It has fan-shaped leaves with stiff leaflets. The inflorescences form among leaves. The flowers are hermaphrodite.

Chamaesiphonales (division Cyanobacteria) Order of cyanobacteria in which the thallus is polar, attached at one end to algae or to other plants. Exospores or endospores are produced. It is found mostly in marine environments.

chancre Ulcer that develops in the early stages of syphilis.

chancroid Ulcerating sore in the genital region caused by *Haemophilus ducreyi*. It is transmitted by sexual contact.

Chanda ranga (Indian glass fish) *See* Centropomidae.

changeable toad *See Bufo viridis.*

Chanidae (milkfish, salmon-herring; class Osteichthyes, subclass Actinopterygii, order Gonorhynchiformes) Monospecific family (*Chanos chanos*), comprising a fish whose streamlined body, and long, deeply-forked tail-fin give it a graceful appearance. Because of its fairly small, toothless mouth, the single dorsal fin, and the bright, silvery colour, it is sometimes also known as the giant herring. Milkfish often form large schools, swimming near the surface. Along the shores of many tropical countries it is an important source of protein for humans. The young are caught in large numbers, placed in fish ponds, and kept until they are of marketable size. It is found in the tropical waters of the Indo-Pacific and S. American regions, where it can grow to at least 1 m in length.

channelled wrack Common name for the brown seaweed *Pelvetia canaliculata*. The thallus is flattened and branched, the branches lacking a midrib, and having inrolled margins which form moisture-retaining channels. This plant can grow higher on the shore than can any other seaweed: at and above high-water mark. It is used sometimes as fodder for sheep and cattle.

Channichthyidae (crocodile fish, ice fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish with a depressed head and long snout, large mouth and eyes, and long dorsal and anal fins. In many species the blood contains few red blood cells. These fish are apparently rather sluggish, living in the cold waters of the S. Atlantic and antarctic. There are about 16 species.

Channidae (snake-heads; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of tropical, freshwater fish with elongated body, snake-like head, very long dorsal and anal fins, rounded tail and pectoral fins, no fin spines, and the lower jaw protruding beyond the upper. The gill chambers have special modifications enabling the fish to utilize atmospheric oxygen: the fish can live out of water for some time. There are about 11 species, found in tropical Africa and S. Asia. *See also* accessory respiratory organs.

Chanos chanos (milkfish) *See* Chanidae.

chanterelle Common name for the edible fruit body of *Cantharellus cibarius*. The cap is funnel-shaped, and 3–10 cm across; the lower surface bears shallow, branching, gill-like ridges which extend down the short stipe. The whole fruit body is a bright egg-yellow and has a distinctive odour resembling that of apricots. It is common on the ground in summer and autumn, especially under beech or oak trees, and occurs throughout Europe and N. America.

chaparral Sclerophyllous scrub of W. California and adjacent regions. Like other sclerophyllous scrub in regions with Mediterranean-type climates, much of the chaparral has been derived by a combination of burning and other factors from an earlier forest cover.

Chara Alga, known from the Triassic to the present day, which reproduces sexually. The female oogonia are protected by an envelope of calcium carbonate. All fossil charophytes are known only by their calcified oogonia, which often have a spiral ornament.

Characidae (characin, tetra, piranha; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Very large family of freshwater fish. Most are small in size and some are very colourful. All have a single dorsal fin on the back, often a small adipose dorsal fin, a forked tail-fin, and an anal fin which often is larger than the dorsal fin. Many species are extremely popular aquarium fish, including *Paracheirodon innesi* (neon tetra) and *Hemigrammus erythrozonus* (glowlight tetra). One of the most unusual of the characins is *Anoptichthys jordani* (blind cavefish). Living in cave waters, its body lacks pigment and its eyes are vestigial. The family also includes the voracious piranhas, powerfully-built fish with strong jaws and teeth. *Serrasalmus rhombeus* (white piranha) can grow to a length of 30 cm and appears to be a good table fish. There are about 500 species, found in C. and S. America and in Africa.

characin *See* Characidae.

character Any detectable attribute or property of the phenotype of an organism. Defined heritable differences in the character may exist between individuals within a species.

characteristic species *See* kennarten species.

charade *See* dance language.

Charadriidae (plovers; order Charadriiformes) Family of medium-sized brown, grey, or black and white waders, with head and neck often boldly marked. Some are crested or have wattles. They have short necks and long wings, some with spurs, and their legs are short to long with a reduced or absent hallux. They inhabit open, bare areas, nesting on the ground and feeding on a variety of animal matter. Most are migratory. There are 11–13 genera, with 60–65 species, found worldwide.

Charadriiformes (waders, gulls, skuas, terns, auks, plovers; class Aves) Large, diverse order containing 14 families of birds that live on, or near, water, and whose young are active and covered in down at hatching: Jacanidae, Rostratulidae, Haematopodidae, Charadriidae, Scolopacidae, Dromadidae, Burhinidae, Glareolidae, Thinocoridae, Chionididae, Stercorariidae, Laridae, Rhynchopidae, and Alcidae. Some authorities also include the Recurvirostridae (avocets, stilts) as a family within this order.

Charadrius (plovers; family Charadriidae) Genus of small to medium-sized brown and white plovers with distinctive head and breast patterns. They are found mainly in open ground near salt or fresh water, feeding on insect larvae, worms, molluscs, and crustacea. Many are migratory. There are 20–30 species found worldwide.

Charophyta Division of plants the members of which are usually regarded as algae, although they resemble bryophytes in the structure of the male gametes and in the presence of a sterile envelope enclosing the sex organs. Many species are heavily calcified. The plants are aquatic, occurring primarily in fresh water, although some species are found in brackish water. *See also* stonewort.

chart datum Datum, or plane, to which depth measurements on a chart are referred.

chase 1 In Britain, a royal forest that has passed into private ownership. 2 A lane between two woods.

chats *See Saxicola*.

chattermark Small (less than 5 mm) crescentic scar typically found on the surface of rounded beach pebbles made of flint. It is a percussion fracture, produced when pebbles are thrown together under storm-wave conditions.

Chattian Final stage of the Oligocene Epoch. It is dated by means of sea-floor spreading rates, small mammals, and plankton.

Chauliodontidae (viperfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of deep-sea fish with an elongated body, tapering down toward the tail, the small dorsal fin not larger than the adipose fin but with a very long first dorsal ray that can be used as a lure. The upper and lower jaws have long, needle-like teeth, giving the head a ferocious appearance. There are about six species, with some, e.g. *Chauliodus macouni*, showing a row of luminous organs along the belly.

chaulmoogra oil *See Hydnocarpus*.

Chaunacidae (sea toad; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of marine fish with a balloon-shaped body, an oblique mouth, and the gill opening behind the pectoral fin. They are distributed worldwide.

cheek teeth Premolar and molar teeth.

cheetah (*Acinonyx jubatus*) *See* Felidae.

Cheilinus undulatus (giant maori wrasse) *See* Labridae.

Cheilodactylidae (morwong; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of fairly large marine fish. The body is very deep just behind the head, but tapers sharply toward the tail. The continuous, spinous, and soft-rayed dorsal fin has a very long base, but the anal fin is short. Morwongs tend to be 'thick-lipped', with a small, fringed tentale near the anterior nostril. The tips of the lower pectoral rays project well beyond the fin membrane. The fish are found in the temperate waters of the southern hemisphere, and near Japan. They are well represented in S. Australia and New Zealand, and such species as *Nemadactylus macropterus* (jackass morwong) and *Cheilodactylus douglasii* (common morwong) are of commercial importance in this region. *Dactylophora nigricans* (dusky morwong) may reach a length of 1.2 m.

Cheilodactylus douglasii (common morwong) *See* Cheilodactylidae.

Cheilostomata (subphylum Ectoprocta, class Gymnolaemata) Large order of bryozoans, which are highly variable in gross morphology, and are characterized by the presence of a small, non-calcified operculum which covers the aperture when the soft parts are withdrawn. The order occurs from the Jurassic to Recent.

Cheirogaleidae (order Primates, suborder Strepsirhini) Family of small lemurs in which the eyes are large and the muzzle short. They are entirely nocturnal, and during the dry season they aestivate in nests made from leaves, sustaining themselves on reserves of body fat accumulated mainly at the base of the tail. There are four genera, *Cheirogaleus* (dwarf lemurs), *Microcebus* (mouse lemurs), *Allocebus* (the, very rare, hairy-eared mouse lemur), and *Phaner* (fork-crowned lemur).

Cheirolepis trailli Early representative of the primitive bony fish, the palaeoniscids. It is known from the Middle Devonian.

chela Prehensile claw or pincer, e.g. in Crustacea.

chelate 1 Pincer-like. 2 Ring structure formed as a result of the reaction of a metal ion with two or more groups on a ligand.

chelation Equilibrium reaction between a metallic ion and an organic molecule in which more than one bond links the two components. The metallic ion is termed the complexing agent, the chelating organic molecule the ligand. Chelation is a naturally-occurring mechanism in soils, useful since it removes heavy-metal ions that are in solution in simple inorganic form where they may be directly toxic to plants or may interfere with the uptake of essential nutrients. Heavy-metal toxicity in waste-land will tend to be reduced by the application of organic material.

chelicera One of the first pair of the six pairs of appendages on the prosoma of an arachnid, which has no more than three segments. In most orders the terminal segment is chelate (pincer-like), while in spiders and amblypygids it is subchelate. In mites, especially parasitic species, the chelicerae become narrowed and lose the chelate finger, becoming a piercing structure. The chelicerae are generally held parallel and anterior to the body, working alternately. If they are large, as in spiders, Solifugae, and harvestmen, they serve as prehensile organs, squeezing and killing prey, and are also used in defence and in digging. In spiders, a poison gland opens at the apex of the terminal article, and in pseudoscorpions a silk gland opens in the same location.

Chelidae (snake-necked turtles; order Chelonia (Testudines), suborder Pleurodira) Family of freshwater turtles in which the head and neck may be longer than the carapace. The neck vertebrae fold only sideways. The turtles' diet is mixed. There are 31 species, occurring in S. America, Australia, and New Guinea. *See also Chelus fimbriatus*.

cheliped *See* Decapoda.

Chelisochidae (class Insecta, order Dermaptera) Small family of earwigs, small to medium in size and generally less than 3 cm long, which show no striking distinguishing features. Most of them are found in the tropics.

Chelonia (Testudines; turtles, terrapins, tortoises) Order of reptiles in which the body is enclosed in a shell of bony plates covered by horny scales with an upper carapace and lower plastron. The carapace is often fused to the vertebrae and ribs. The jaws are toothless, and horny. There are some 250 species, including marine, freshwater, and terrestrial forms.

Chelonia mydas (green turtle; order Chelonia (Testudines), suborder Cryptodira, family Cheloniidae) Species of turtles of shallow tropical seas. The carapace has thin, horny plates that do not overlap, measuring approximately 100 cm, being larger in males. They are basically herbivorous, but occasionally they eat molluscs and crustaceans. They lay 250–500 eggs.

chelonians *See* Chelonia.

Cheloniidae (marine turtles; order Chelonia (Testudines), suborder Cryptodira) Family of turtles in which the shell consists of a carapace that flat and streamlined, and a plastron that is reduced. The forelimbs are broad, and flat, with one or two claws. The hind limbs are flattened, and rudder-like. Neither the head nor legs retract into the shell. These turtles are mainly carnivorous. There are five species, with a cosmopolitan distribution in warm seas. They come ashore only to lay eggs. *See also Caretta caretta*; *Chelonia mydas*; and *Eretmochelys imbricata*.

chelophore In Pycnogonida, one of the appendages located on either side of the proboscis: it bears a chelicera at the tip and functions as a mouthpart.

Chelus fimbriatus (matamara; order Chelonia (Testudines), suborder Pleurodira, family Chelidae) Species of turtle which inhabits stagnant pools in tropical S. America. The head is large and flattened, with nostrils at the end of a slender proboscis; the neck is long; and the carapace is up to 45 cm long, with three ridges and covered with small knobs. Small prey are rapidly sucked into the large mouth cavity.

Chelydridae (snapping turtles; order Chelonia (Testudines), suborder Cryptodira) Family of freshwater turtles in which the head is large, with knobs of skin around the face. The carapace is incompletely ossified, and the plastron is reduced to a cross-strut. The tail is long, with lateral spines. Snapping turtles are carnivorous and obtain food on the bottom of ponds and rivers. There are two species, found in the USA.

chemical evolution The process that is assumed to have led to the origin of life on Earth more than 3300 million years ago. The classical view is that lightning discharges in the Earth's early atmosphere produced the basic organic molecules from which, after they had dissolved in the oceans, life was assembled. How the assembly was achieved is still largely a matter of conjecture.

chemical oxygen demand (COD) Indicator of water or effluent quality, which measures oxygen demand by chemical (as distinct from biological) means, using potassium dichromate as the oxidizing agent. Oxidation takes two hours and the method is thus much quicker than a five-day BOD assessment. Since the BOD : COD ratio is fairly constant for a given effluent, COD is used more frequently for routine monitoring of an effluent once this ratio has been determined.

chemiosmotic theory Theory concerning oxidative phosphorylation in which it is proposed that the electron-transport chain is arranged such that it generates an energy-rich proton gradient across the inner membrane of a mitochondrion. This energy is then used to drive the phosphorylation of ADP through a membrane-bound ATP-ase.

chemo-autotroph Chemotrophic organism that uses carbon dioxide as its main or sole source of carbon.

chemoheterotroph Chemotrophic organism that obtains its carbon chiefly or solely from organic compounds.

chemolithotroph Chemotrophic organism that obtains its energy from the oxidation of inorganic compounds or elements.

chemo-organotroph Chemotrophic organism that obtains its energy from the metabolism of organic compounds.

chemostat Apparatus that allows bacterial populations to be kept in a state of continuous division for many generations.

chemotaxis In a motile organism or cell, a change in the direction of locomotion, made in response to a change in the concentrations of particular chemicals in its environment.

chemotroph Organism that obtains its energy from chemical reactions. *Compare* phototroph.

chengal The wood of *Neobalanocarpus heimii*. *See also Neobalanocarpus*.

chenier Beach ridge, or sandy, linear mound that is built on a marsh area. It is 150–200 m broad, up to 3 m high, and 50 km long, and is typical of the Gulf Coast of America. The chenier is formed by the wave reworking of river-derived materials. There are usually muddy, marshy zones to the front and rear of the chenier.

chenier plain Area of marine aggradation consisting of sandy ridges (cheniers) separated by clay-rich depressions. Occasionally the ridges may be vegetated, as on the Gulf Coast of the USA. They may be large: the chenier plain of the north coast of S. America is about 2250 km long and up to 30 km wide.

Chenopodiaceae (goosefoots) Family mostly of herbs but some shrubs, which are frequently succulent, or covered with mealy hairs. The leaves are mostly simple, and alternate. The flowers are inconspicuous, borne in dense clusters, bisexual or unisexual, and tri- to pentamerous; and have a superior ovary of one cell. The fruits are one-seeded nuts. *Beta* (beetroot, sugar beet) and *Spinachia* (spinach) are important vegetables or sources of sugar. There are about 75 genera, with 500 species, cosmopolitan in distribution but occurring mainly in arid regions or saline habitats, and also as weeds in enriched cultivated or waste ground.

chequered beetle *See* Cleridae.

cherimoyer (*Annona cherimola*) *See Annona*.

chernozem (black earth) Freely-draining soil profile whose name is the Russian word for 'black earth'. Chernozems are associated with grassland vegetation in temperate climates, and identified by the deep and even distribution of humus and of exchangeable cations (calcium and magnesium) through the profile (included in Mollisols of the USDA Soil Taxonomy).

cherries *See Prunus*.

chert Variety of silica that lacks external evidence of crystal form. It is chalcedony (SiO_2) in a nodular or lens-like habit. Under magnification it is seen to be extremely fine-grained, and may be termed 'crypto-crystalline'.

chervil (*Anthriscus cerefolium*) *See Anthriscus*.

chestnut 1 (Castanea) See Fagaceae. 2 (horse-chestnut) See Hippocastanaceae.

chestnut blight Disease of chestnut trees caused by the fungus *Endothia parasitica*. The disease is systemic and results in wilting and death. The introduction of the fungus to America from Asia led to the wholesale destruction of the hitherto commercially important American chestnut (*Castanea dentata*).

chevrotain (*Tragulus*, *Hyemoschus*) *See* Tragulidae.

chewing gum *See Dyera*.

chewing lice *See* Mallophaga.

chiasma (pl. chiasmata) In genetics, a cross-shaped structure forming the points of contact between non-sister chromatids of homologous chromosomes first seen in the tetrads of the diplotene stage of meiotic prophase. Chiasmata are thus the visible expression of crossing-over of genes. There are usually one or more chiasmata per chromosome per meiosis. *See also* breakage and reunion.

chiasma interference The non-random frequency of more than one chiasma in a bivalent segment during meiosis. If the frequency of occurrence is higher than that expected from purely chance events then it is termed negative chiasma interference; if the frequency is lower than expected, it is referred to as positive chiasma interference.

chiasmata *See* chiasma.

Chiasmodon niger (swallower) *See* Chiasmodontidae; and bathypelagic fish.

Chiasmodontidae (swallower; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of deep-sea fish with a very large, toothed mouth. Swallowers are thought to be capable of swallowing prey larger than themselves. There are about 15 species, occurring in deep oceans.

chickadees *See* Paridae; and *Parus*.

chickenpox (varicella) Acute and highly contagious disease which affects mainly children, often occurring in epidemics. Symptoms include fever and rash. Chickenpox is caused by a virus of the herpesvirus group.

chickrassy *See Chukrasia*.

chicle *See Achras*.

chicory (*Cichorium intybus*) *See Cichorium*.

chiku *See Achras*.

Chikungunya fever Acute disease of humans in tropical and subtropical regions. Symptoms include a rash with aching and swelling of joints. The fever is caused by an alphavirus, and transmitted by mosquitoes (*Aëdes aegypti*).

childbed fever *See* puerperal fever.

Chilean wine palm (*Jubaea spectabilis*) *See Jubaea*.

Chile saltpetre (nitratine, soda nitre) Very soluble mineral, specific gravity 2.2, hardness 1.0–2.0, chemical composition $NaNO_3$, which therefore occurs in arid regions as surface deposits together with gypsum, halite, and other soluble nitrates and sulphates. It is distinguished by its low specific gravity, its solubility in water, its ease of fusibility, and its deliquescence. It is normally colourless or white, with various darker colours due to impurities. It has a white streak, and a vitreous lustre. It crystallizes in the trigonal system. The crystals can be rhombohedral or massive. It is worked as a source of nitrate.

chillies *See Capsicum*.

chilling-sensitive plant Plant that is badly injured or killed by temperatures above freezing point, up to about 20 °C.

Chilodontidae (head-stander; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish with a single dorsal fin and an adipose fin, a small mouth, and a forked tail-fin. These fish often swim in a head-down position. They occur in S. Australia.

chimaera *See* chimera.

Chimaera monstrosa (rabbitfish) *See* Chimaeridae.

Chimaeridae (ghostfish, ratfish; class Chondrichthyes, subclass Holocephali, order Chimaeriformes) Family of marine, oceanic fish with large eyes, a short and rounded snout, and a strongly tapering body which ends in a narrow, filament-like tail. The first of the two dorsal fins has a strong spine at the leading edge; the pectoral fins are large and wing-like. The rabbitfish of W. Europe (*Chimaera monstrosa*) lives close to the bottom, at 100–500 m and may grow to 1.2 m. It is of some commercial importance in a number of countries. There are about 15 species, with a worldwide distribution.

Chimaeriformes (class Chondrichthyes, subclass Holocephali) Order of marine fish with a cartilaginous skeleton, a gill cover over the four gill openings, a naked skin, and no spiracle opening. The males have a pair of pelvic claspers and a peculiar clasping structure on the head. The order includes a number of fossil families as well as the living ghostfish. They are not considered to be closely related to either the sharks or the bony fish.

chimera (chimaera) Tissue containing two or more genetically distinct cell types, or an individual composed of such tissues. It arises as a result either of (a) mutation or of abnormal distribution of chromosomes, affecting a particular cell during development and hence all its descendants, or (b), in the case of plants, by the artificial grafting together of two individuals with different genotypes, to produce a mixing of characters. It is also referred to as a mosaic.

chimpanzee (*Pan troglodytes*) *See* Pongidae.

China jute (*Abutilon avicenae*) *See Abutilon*.

chinaman leatherjacket (*Nelusetta ayraudi*) *See* Monacanthidae.

chinch bug *See* Lygaeidae.

Chinchillidae (chinchillas, vizcachas; order Rodentia, suborder Hystricomorpha) Family of rodents which shelter in crevices or burrows. The hind limbs are long, with three or four digits, the forelimbs short with four or five digits. The eyes are

large, the ears rounded, and in some species large. The tail is long, and in some species bushy. They are found in southern S. America. There are six species in three genera: *Chinchilla*, *Lagidium*, and *Lagostomus*. The Chilean chinchilla (*C. laniger*), an animal about 23 cm long excluding the tail, is raised in captivity for its fur, which has been prized at least since Inca times; in the past chinchillas have also been a source of meat.

chine Precipitous ravine typically found along eroding coastlines developed in the softer Mesozoic and Cenozoic sediments e.g. of S. England. It results from the rapid incision that occurs when a stream responds by downcutting to the rejuvenating effect of coastline retreat.

Chinese lacquer *See Rhus*.

Chinese pygmy dormouse (*Typhlomys*) *See* Platacanthomyidae.

Chinese swamp cypress (*Glyptostrobus lineatus*) *See Glyptostrobus*.

Chinese water chestnut (*Eleocharis tuberosus*) *See Eleocharis*.

chin-leafed bat (*Mormoops*, *Pterontus*) *See* Mormoopidae.

chinook Warm, dry, westerly wind of the föhn type which blows on the eastern side of the Rocky Mountains. The quick onset of the wind and the sudden large rise in temperature is associated in spring with rapid melting of the snow.

Chionididae (sheathbills; order Charadriiformes) Family of white, pigeon-like birds with short, stout legs and unwebbed feet. The stout bill is black, or yellow and black, and covered by a horny sheath. Chionidids have bare and wattled cheeks. Their wings have sharp carpal spurs. They are gregarious and mainly terrestrial, omnivorous and hole-nesting in crevices and burrows. There are two species, found on sub-antarctic Atlantic and Indian Ocean islands.

chipmunk (*Tamias*, *Eutamias*) *See* Sciuridae.

Chirocentridae (wolfherring; class Osteichthyes, subclass Actinopterygii, order Clupeiformes) Monospecific family of marine warm- to temperate-water fish. The wolfherring has an elongate body, a large mouth with fang-like teeth, and a single dorsal fin located close to the forked tail-fin. A voracious carnivore, the only extant species *Chirocentrus dorab* is a very large, silvery fish, reaching a length of up to 3.5 m. It is widely distributed in Indo-Pacific waters.

Chirocentrus dorab (wolfherring) *See* Chirocentridae.

Chironemidae (kelpfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine coastal fish. Because of the high-backed body profile, and the lower pectoral ray tips projecting free from the fin membrane, the kelpfish resemble the morwongs (family Cheilodactylidae). However, kelpfish such as *Chironemus marmoratus* of E. Australia and New Zealand have a truncate tail fin and fewer (less than nine) soft anal-fin rays. There are about four species, found in temperate waters around the Tasman Sea. Because of the somewhat marbled colour pattern, they can hide easily in shallow rocky areas.

Chironemus marmoratus *See* Chironemidae.

Chironomidae (non-biting midges; class Insecta, order Diptera, suborder Nematocera) Family of delicate, gnat-like flies, in which the males have conspicuous, plumose antennae, and those of females are pilose. The head is usually overhung, and often concealed, by the thorax. Mouthparts are poorly developed. Anterior wing veins are more prominent than posterior ones. Adults bear some resemblance to Culicidae, but can be distinguished by their unscaled wings. Adults fly in large numbers at sunset near standing bodies of water. The swarms comprise mainly males, and mating occurs when a female flies into a swarm. Eggs are laid in a mass, or ribbon of clear, mucus-like jelly. Larvae are almost all aquatic, or mud-dwellers that live in tubes. Some species have larvae containing haemoglobin as an adaptation to life in anoxic substrates. Some species can reproduce parthenogenetically, and paedogenesis has been recorded in others. There are some 2000 described species.

Chiroptera (bats; class Mammalia, subclass Theria, infraclass Eutheria, cohort Unguiculata) Order comprising the only true flying mammals, possessing features parallel to those of birds, e.g. active metabolism, economy of weight. Insectivores possibly ancestral to the bats are known from the Palaeocene. The first undoubted bats, however, are preserved in Middle Eocene deposits in both Europe and N. America. Differentiation of the modern lineages was far advanced by the Eocene–Oligocene transition. The wing is a patagium (skin membrane) supported by four, or in some species all five, elongated digits of the forelimb, and attached along the sides of the body, the legs (leaving the feet free), and in most species the tail. The pelvis is weak but adapted to enable the legs to rotate to the rear so that the bat can hang head-down. The orbit is rarely closed behind. The incisors are often specialized or reduced. There are two suborders: Megachiroptera and Microchiroptera.

Chisocheton (family Meliaceae) Genus of rainforest trees or treelets in which the leaves are remarkable, being pinnate with an intermittently growing terminal bud. The fruit is a globose, usually velvety, thick-walled capsule, and the seeds are large, with a fleshy jacket. There are about 30 species, occurring from Indo-Malesia to Vanuatu.

chitin Linear homopolysaccharide of *N*-acetyl-D-glucosamine found as a major constituent of fungal cell walls, and as the major component of the cuticle of an insect, in which the molecules are layered down in chains. Depending on their orientation, these chains can be cross-linked to yield a very strong, lightweight material from which, with the addition of protein, the exoskeleton is constructed.

Chitinodendron franconianum Although single-celled organisms are known from Precambrian strata, the first protozoons with an external skeleton

appear in the Upper Cambrian. *C. franconianum*, which has a 'chitinoid' membrane externally, is a primitive allogrominid foraminifer. It is from the Upper Cambrian of Wisconsin, USA.

chitons *See* Polyplacophora.

Chlamydia (order Chlamydiales) Genus of bacteria with the characteristics of the order. There are two species, both of which are parasitic and capable of causing disease, e.g. trachoma, and psittacosis.

Chlamydiales Order of bacteria in which the growth cycle involves the alternate formation of two distinct cell types, only one of which can undergo cell division. There is one family, with one genus. They are found as parasites in various types of vertebrate host.

Chlamydomonas (family Chlamydomonadaceae, order Volvocales) Genus of unicellular green algae in which each cell contains a single nucleus and a cup-shaped chloroplast. The cell may be motile or non-motile according to conditions of growth: motile cells have a pair of similar flagella at one end. There are many species. They are widely distributed and common, found in almost all types of aquatic environment and on moist soil. *C. nivalis* can grow on snow in mountains in N. America, the masses of cells giving rise to a reddish coloration known as 'red snow'.

Chlamydosaurus kingii (frilled lizard; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Species of long-tailed, Australian agamids (length up to 90 cm) which are mainly arboreal, but which may run bipedally on the ground. A thin fold of skin, supported by rays of cartilage, forms an erectile collar (about 13 cm in diameter) around the throat.

Chlamydoselachidae (frill shark; class Chondrichthyes, subclass Elasmobranchii, order Hexanchiformes) Family consisting of only one species of marine shark, *Chlamydoselachus anguineus*, which is recognizable by the presence of six pairs of gill clefts, the first one continuing below the throat to join its counterpart on the other side. The single dorsal and the anal fins are set far back on the body. The frill shark has a somewhat snake-like appearance due to its elongate body, flat head, and large mouth. Probably it is a deep-water shark. It has a worldwide distribution.

Chlamydoselachus anguineus (frill shark) *See* Chlamydoselachidae.

chlamydospore Thick-walled fungal spore formed from a cell in a vegetative hypha.

Chloanthus (family Verbenaceae) Genus of small shrubs with soft, hairy leaves and yellow-green or yellow-red tubular flowers, with upper and lower lips. There are very few species (formerly the genus was thought to be monospecific), endemic to Australia.

chloramphenicol Broad-spectrum antibiotic produced by *Streptomyces venezuelae*. It acts by inhibiting protein synthesis in bacteria by binding to certain ribosomes in preference to messenger-RNA. Thus peptide-bond formation is prevented.

Chloranthaceae Family of trees, shrubs, or herbs, which are often rather succulent. The leaves are opposite. The flowers are tiny, reduced, and borne on spicate racemes. The fruit is a tiny drupe. The family is related to Lauraceae. There are five genera, with 65 species, occurring in tropical America, and from China and India to Melanesia and New Zealand.

Chlorella (family Oocystaceae, order Chlorococcales) Genus of non-motile, unicellular green algae. Each cell contains a single cup-shaped chloroplast. Cells divide to form two or four daughter cells which resemble the parent cell and are initially enclosed within the parent cell wall. *Chlorella* is very common in a wide range of habitats, often colouring small bodies of standing water (e.g. drinking troughs) a pea-soup green.

chlorine (Cl) Element which is necessary for normal plant growth. Its main role seems to be that of controlling turgor, but it may also be involved in the light reaction of photosynthesis. If plants are deficient in chloride ions, wilting occurs, and the young leaves become blue-green and shiny. Later they become bronze-coloured and chlorotic.

chlorinity Measure of the chloride content, by mass, of sea-water. It is defined as the amount of chlorine, in grams, in 1 kg of sea-water (bromine and iodine are assumed to have been replaced by chlorine). Chlorinity and salinity are both measures of the saltiness of sea-water. The relationship can be expressed mathematically as salinity is equivalent to 1.80655 times the chlorinity.

Chloris (family Gramineae, tribe Chlorideae) One of the nine genera of grasses that are represented in all arid regions of the world. They are typical components of arid grazed habitats, and several species are valuable pasture grasses. The genus is cosmopolitan, with about 12 species.

chlorite *See* clay minerals.

Chlorobiaceae (green sulphur bacteria; order Rhodospirillales) Family of photosynthetic bacteria which use sulphide as a source of reduction for photosynthesis. Sulphur is sometimes produced, but never inside the cells. All species are non-motile. Cells of different species are spherical, curved or straight rods, or ovoid. Cells may be organized into chains, clumps, nets, spirals, etc. Photosynthetic pigments are attached to membrane vesicles linked to, but not continuous with, the cytoplasmic membrane. There are several species, found in sulphide-rich, anaerobic, aquatic environments, often forming greenish or brownish blooms.

Chlorococcales (class Chlorophyceae) Order of green algae in which the cells occur singly, or in coenobia; vegetative forms are non-motile. There are five families, found in freshwater habitats, and on damp soil, brick, etc.

chlorocruorin Green, respiratory pigment, of molecular weight 3.5×10^6, that contains iron in its prosthetic group. It occurs only in the blood plasma of certain polychaete worms.

Chlorocyphidae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies which can be identified by the many antenodal veins, with obvious primaries, on the wings. The insects are often very colourful, and fly by streams or rivers in shady areas. In the nymph, the medial caudal gill is reduced to a spike. More than 230 extant species have been described, and the family occurs in the Old World tropics.

Chloroflexaceae (Order Rhodospirillales) Family of filamentous, thermophilic, photosynthetic bacteria which are capable of a gliding motility when in contact with a surface. They are predominantly photo-organotrophic under anaerobic conditions in the presence of light, but chemo-organotrophic under aerobic conditions. Their colour is green in the absence of air, but orange in the presence of air. Vesicles containing photosynthetic pigments are attached to, but not continuous with, the cytoplasmic membrane. So far only one species, *Chloroflexus aurantiacus*, is known. It is found in hot springs, where it forms dull-green or orange mats.

Chloroflexus aurantiacus *See* Chloroflexaceae.

Chlorolestidae (Synlestidae, damselflies; order Odonata, suborder Zygoptera) Family of damselflies which breed in running water. They are distinguished by the arching forward of the posterior cubitus vein as it leaves the distal end of the quadrilateral in the wing. These damselflies are often elongate, and metallic in colour. The family is mainly tropical, and 33 extant species have been described.

Chlorophora (family Moraceae) Genus of trees which includes *C. excelsa* (iroko of Africa) and *C. tinctoria* (fustic, of the West Indies and S. America), both of which are important timber trees. There are 12 species, occurring in tropical America, Africa, and Madagascar.

Chlorophthalmidae (cucumberfish, greeneye; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine, coastal fish with an elongate body, large eyes (appearing green in live fish), a single dorsal fin followed by a small adipose fin, and a forked tail-fin. In Australia, *Chlorophthalmus nigripinnis* (cucumberfish), found in the cooler southern waters, derives its name from the peculiar smell emanating from the skin. There are about 20 species, with worldwide distribution.

Chlorophthalmus nigripinnis (cucumberfish) *See* Chlorophthalmidae.

Chlorophyceae (green algae) Class of algae which are typically green in colour. The storage product (starch) is formed in chloroplasts rather than in the cytoplasm. The organisms take many forms, ranging from unicellular to relatively complex multicellular plants. They are found mainly in freshwater habitats, and their distribution is cosmopolitan. They are known from the Precambrian to the present, and the earliest eukaryotes were probably of this class.

chlorophyll Green pigment in plants that functions in photosynthesis by absorbing radiant energy from the Sun, predominantly from blue (435–438 nm) and red (670–680 nm) regions of the spectrum. The light removes an electron from the chlorophyll molecule: this is used either to produce ATP or to produce a reductant NADPH for carbon-dioxide fixation. Chlorophylls are magnesium-porphyrin derivatives, the principal variants in land plants being designated chlorphylls *a* and *b*, and in marine algae *c* and *d*.

chlorophyll method Method for estimating the primary productivity of ecosystems. Experimental evidence shows that, with appropriate calibration, the chlorophyll content of the community occupying a given area can form an index of the area's productivity. The method was pioneered for marine ecosystems, but has now been extended to other aquatic and to terrestrial communities.

Chlorophyta Division that includes the green algae of the class Chlorophyceae.

Chloropidae (frit flies, grass flies, stem flies; class Insecta, order Diptera) Moderately large family of small flies, of some economic importance as pests of plants. Adults are usually black, yellow-black, or green-black, and almost without bristles. They may be identified by the large, triangular, ocellar plate on the dorsal surface of the head. The wing costa is interrupted at R_1, and Sc is barely visible except as a fold. Veins 1A and M_4 are not developed, and cell Cu_2 is absent (*see* venation). Males have lost abdominal tergites 7 and 8. The larvae are mainly phytophagous, the exceptions being predacious. *Oscinella frit* (frit fly) is a pest of cereals in Europe, the larvae feeding inside shoots. Several other species affect mainly cultivated Gramineae. 1180 species have been described.

chloroplast Biconvex, or plano-convex plastid, typically 5–10 μm long and 2–3 μm wide. It has a complex internal structure comprising stacks of membranaceous discs or grana that bear photosynthetic pigments embedded in a matrix or stroma. It is a semi-autonomous organelle containing some genetic material and has some ability to direct the synthesis of its own proteins.

Chloropsis (leafbirds; family Irenidae) Genus of bright-green leafbirds with slightly decurved, pointed bills. They are arboreal, feeding on nectar, fruit, and berries, and building a cup-shaped nest in trees. They are popular cagebirds. There are eight species found in S. and SE Asia, Indonesia, and the Philippines.

chlorosis (adj. chlorotic) Symptom of disease or disorder in plants, involving a reduction in or loss of the normal green coloration.

Chlorosplenium (order Helotiales) Genus of fungi in which the hymenium lines cup-shaped apothecia. In *C. aeruginascens* (*Chlorociboria aeruginascens*) the apothecia are stalked, shallowly cup-shaped, and 5–10 mm across. This species grows chiefly on oak wood, which consequently becomes stained a bright blue-green and is valued for decorative purposes.

chlorotic *See* chlorosis.

Chloroxylon (family Rutaceae) Monotypic genus, comprising *C. swietenia*. This yields satinwood, an

attractive pale timber used for veneer, and also a gum. It occurs in Sri Lanka and India.

choaenae Internal nostrils; paired openings in the roof of the mouth which are connected to the exterior.

Choanephoraceae (order Mucorales) Family of fungi which, typically, form both sporangia and sporangiola. The columellate sporangia contain dark-brown spores and typically hang. There are three genera, with several species, found on fruit, and flowers.

Choanichthyes (Sarcopterygii) Term used by some zoologists to group together Crossopterygii, or lobe-finned fish, and Dipneusti, or lungfish. Members of this group or subclass were thought to share functional lungs, external and internal nares (choanae), and narrow-based, paired fins with fleshy lobes.

choanocyte In Porifera (sponges), one of the flagellated cells surrounded by a collar-like sheath of protoplasm that form a layer lining the internal chambers. Choanocytes are very similar in structure to choanoflagellate protozoa.

choke, of grasses Disease which can affect many types of grass, particularly cocksfoot (*Dactylis glomerata*) and timothy (*Phleum pratense*). The causal agent is the fungus *Epichloe typhina*. A ring of white, felt-like mycelium develops around the flower-stalk and becomes yellow, then orange, as the fungal perithecia develop.

cholera Acute, infectious disease of humans, caused by certain strains of the bacterium *Vibrio cholerae*. Infection occurs as a result of the ingestion of food or water contaminated with the pathogen. Symptoms include nausea, vomiting, diarrhoea, and cramp-like abdominal pains; the passing of thin 'rice-water' stools leads to dehydration. In untreated cases the disease may be fatal.

cholesterol The most abundant sterol in animal tissues, derived endogenously from acetyl coenzyme A, or exogenously from food. It is a precursor of steroid hormones and bile acids.

choline Basic, nitrogenous organic compound that functions as a methyl-group donor in some phospholipids and in acetylcholine. Although it has no known coenzyme function, it is normally classified as one of the B group of vitamins.

cholinergic system *See* neurotransmitter.

Chondrichthyes Class of vertebrate animals characterized by a cartilaginous endoskeleton, a skin covered by placoid scales, the structure of fin rays, and the absence of a bony operculum, lungs, and swim bladder. It includes the subclasses Elasmobranchii (sharks, rays) and Holocephali (ghostfish). The group extends back to the Upper Devonian. It is not clear whether the cartilaginous skeleton is a primitive feature or the result of young fish reaching reproductive age prematurely, before the normal bony skeleton develops.

chondrite Stony meteorite with 46% olivine, 25% pyroxene, 11% feldspar, and 12% iron–nickel, often containing small, more or less spherical mineral bodies (chondrules), and thought to have developed from the internal condensates of small protoplanets at the beginning of the solar system, approximately 4600 million years ago. Sometimes chondrites are used as a chemical model for the bulk composition of Earth, but there are notable discrepancies, e.g. in the proportions of volatile elements.

Chondrophora (class Hydrozoa) Order of Cnidaria whose members are characterized by having a single, large polyp possessing a chitinous, gas-filled float supporting the other zooids. They have free medusae.

chondrophore **1** In certain genera of pelecypods which possess desmodont dentition, an internal process with a depressed surface that supports the ligament. **2** In some bivalve molluscs, the pit on the side of the valves to which the internal ligament is attached.

Chondrophorina Alternative name for the cnidarian order Chondrophora. In this form it is regarded as a suborder of Siphonophorida.

Chondrostei Group of bony fish belonging to the subclass Actinopterygii. Often ranked as an infra-order, the chondrosteans have a partly cartilaginous skeleton, a heterocercal tail, a spiracle, and an intestinal spiral valve. Apart from a number of fossil orders, it includes the extant order Acipenseriformes.

Chondrostereum purpureum *See Stereum*.

chondrule *See* chondrite.

Chondrus (order Gigartinales) Genus of red seaweeds which includes only one British species: *C. crispus* ('Irish moss'). The thallus is rather variable in both form and colour. The fronds are flattened and strap-like, extensive dichotomous branching giving rise to a bushy, tufted habit. They are usually purplish-red, but may be green in strong sunlight. They are found attached to rocks in pools on the lower part of the intertidal region, and below the low-water mark.

Chonotrichida (subclass Holotrichia) Order of protozoa in which mature individuals lack body cilia but have cilia in the oral region. Immature forms have body cilia. Chonotrichida are found attached to crustaceans in various types of aquatic environment.

chorda dorsalis *See* notochord.

Chordata Large phylum comprising the animals that possess a rod of flexible tissue (notochord), which is protected in higher forms by a vertebral column. The phylum includes *Amphioxus*, fish, amphibians, reptiles, birds, and mammals. The first chordates and the earliest vertebrates are both found in Cambrian rocks.

-chore Suffix adopted in a little-used classification scheme proposed for seed-dispersal mechanisms. Ten categories, or chores, are recognized, e.g. pterochore (winged seeds dispersed by the wind).

Choretrum (family Santalaceae) Genus of shrubs which are root parasites. There are six species,

endemic to Australia and found in the east of the country.

chorion 1 Outer cellular layer of the embryo sac of reptiles, birds, and mammals. It consists of two epithelial layers, an ectoderm surrounding a mesoderm layer. In mammals, the outer epithelium (trophoblast) of the chorion forms the placenta, maintaining close contact with the maternal tissues. *See also* amnion. 2 Structurally complex outer coat of an insect egg, which is often externally patterned, frequently reflecting the pattern of follicle cells in the ovary that laid it down.

Choristida (class Demospongiae, subclass Tetractinomorpha) Order of sponges which have complex body shapes. Organic fibre and spicules are normally present, and the spicules often have long shafts. A cortex is developed. The group first appeared in the Carboniferous.

chroma One of the three variables (hue and value being the others) of colour, chroma measures the strength, wavelength purity, or saturation of colour. *See* Munsell colour.

Chromatiaceae (purple sulphur bacteria; order Rhodospirillales) Family of photosynthetic bacteria that use sulphur, sulphide, or other reduced inorganic sulphur compounds as sources of reduction for photosynthesis. Most species accumulate granules of sulphur inside their cells. Many species are motile with flagella. Cells are spherical, spiral, ovoid or rod-shaped, and range in colour from pinkish-red to orange-brown. Cells may occur singly or as aggregates embedded in slime. Photosynthetic pigments are attached to membranes which are continuous with the cytoplasmic membrane. There are 10 genera, with 26 species, found in sulphide-rich, anaerobic, aquatic environments, often forming pink to purple-red blooms.

chromatid One of the two daughter strands of a chromosome that has undergone division. Chromatids are joined together by a single centromere, usually positioned in the centre of the pair as they lie beside one another. When the centromere divides at anaphase of mitosis or meiosis, the sister chromatids become separate chromosomes.

chromatid interference Non-random participation of non-sister chromatids of a tetrad in successive cross-overs of meiosis: it results in a deviation from the expected 1 : 2 : 1 ratio for the frequencies of two-, three-, and four-strand double cross-overs.

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chromatin The substance of chromosomes, which includes DNA, chromosomal proteins, and chromosomal RNA. Chromatin stains strongly with basic dyes.

chromatography Analytical technique for the separation of the components of complex mixtures, based on their repetitive distribution between a mobile phase (of gas or liquid) and a stationary phase (of solids or liquid-coated solids). The distribution of the different component molecules between the two phases is dependent on the method of chromatography used (e.g. gel-filtration, or ion-exchange), and on the movement of the mobile phase (which results in the differential migration and therefore separation of the components along the stationary phase).

chromatophore 1 Pigmented plastid of a plant cell. 2 In prokaryotic organisms, a membrane-bounded vesicle containing photosynthetic pigment. 3 In many animals, a cell containing pigment granules: by dispersing or contracting such granules certain animals are able to change their colour.

Chromis chromis (damselfish) *See* Pomacentridae.

chromomere Small beadlike structure visible in a chromosome during prophase of meiosis and mitosis, when it is relatively uncoiled (in particular at the leptotene and zygotene stages of meiosis). In polytene chromosomes, the chromomeres lie in parallel, giving the chromosome its banded appearance. Chromomeres in corresponding positions on homologous chromosomes pair during meiosis in many organisms.

chromoplast One of a group of plastids that contain non-photosynthetic pigments. One of their principal functions appears to be that of colour production, presumably as animal attractants. Normally they are derived from chloroplasts or amyloplasts in which the lamellar structure breaks down and carotenoid pigments accumulate irreversibly.

chromosomal puff Localized swelling at a specific site along the length of a polytene chromosome, where DNA–RNA transcription takes place. Large RNA puffs are called Balbiani rings.

chromosome DNA-histone protein thread, usually associated with RNA, occurring in the nucleus of a cell. Although chromosomes are found in all animals and plants, bacteria and viruses contain structures that lack protein and contain only DNA or RNA: these are not chromosomes, though they serve a similar function. Chromosomes occur in pairs, which associate in a particular way during meiosis. Each species tends to have a characteristic number of pairs of chromosomes (23 in humans), found in most nucleated cells within most organisms. The presence of pairs of homologous chromosomes is referred to as the diploid state and is normal for the sexual phase of an organism. Gametes, and cells of the gametophyte of plants, however, are haploid with only one member of each pair in their nuclei. Usually chromosomes are only visible during mitosis or meiosis when they contract to form short thick rods coiled into a spiral. Each chromosome posesses two chromomeres and a centromere, and some contain a nucleolar organizer. Chromosomes contain a line of different genes, a spindle-attachment at some point along their length, and regions of heterochromatin, which stains strongly with basophilic dyes.

chromosome map Map showing the locations (loci) of genes on a chromosome, deduced from genetic-recombination experiments. For example, the frequency of cross-overs between pairs of genes indicate their relative positions or linear order, the distances being given in units of cross-over frequency.

chromosome polymorphism Presence of one or more chromosomes in two or more alternative structural forms within the same interbreeding population.

chromosome substitution Replacement of one or more chromosomes by others (totally or partially homologous) from another source (either a different strain of the same species or a related species that will permit hybridization) by a suitable crossing programme.

chromosome theory of heredity The unifying theory put forward by W. S. Sutton in 1902 that Mendel's laws of inheritance may be explained by assuming that genes are located in specific sites on chromosomes.

chronic (of disease) Applied to a disease that persists for a long time.

chronometry Measurement of time, which in a geological sense is associated with the measurement of absolute ages.

chronosequence Sequence of related soils that differ in their degree of profile development because of differences in their age. Chronosequences can be found in evolving landscapes such as those produced by deglaciation, volcanic activity, wind deposits, or sedimentation.

chronospecies (evolutionary species) According to one view of evolution (that of phyletic gradualism), a new organism may be derived from its ancestor by a process of slow, steady evolutionary change. Conceivably, the descended organism might not be regarded as a member of the same species as its ancestor, in which case it would constitute a new species, in particular a chronospecies.

chronostratigraphy Branch of stratigraphy linked to the concept of time. In chronostratigraphy intervals of geological time are referred to as chronomeres. These may be of unequal duration. Intervals of geological time are given formal names and grouped within a Chronomeric Standard hierarchy. The formal terms are: eon, era, period, epoch, age, and chron. Of these, the last four are the equivalent of system, series, stage and chronozone in the Stratomeric Standard hierarchy. The formal terms are written with initial capital letters when accompanied by the proper names of the intervals to which they refer. Some geologists hold that the term 'chronostratigraphy' is synonymous with 'biostratigraphy', but most agree that the two branches are separate.

Chroococcales (division Cyanobacteria) Order of cyanobacteria in which the cells are solitary, or bound loosely together in a gelatinous matrix. There are many genera. They may be free-floating or terrestrial.

chrysalis Pupal stage of a butterfly, having a hard outer covering beneath which the forming legs, wings, and antennae can sometimes be seen. Chrysalises are usually attached to the underside of leaves, on stems, or on pieces of rock. They are frequently camouflaged to resemble their environment. *See also* Lepidoptera; and pupa.

Chrysididae (ruby-tailed cuckoo wasps, ruby-tailed wasps; suborder Apocrita, superfamily Bethyloidea) Family of wasps which are 6–12 mm long (although some are up to 22 mm long), with bright, metallic blue, red, or green bodies. They resemble the Perilampidae (which are mainly hyperparasites) and some halticid bees. The abdomen has four segments, or fewer, and is concave ventrally. The hindwings do not have closed cells and possess a basal lobe. Some authors place the family within its own superfamily, the Chrysidoidea. Adults lay their eggs in the burrows of solitary wasps or bees (particularly mud-dauber wasps) and some parasitize symphytans. Most larvae are external parasites, development occurring only after the host is completely consumed, although some larvae are inquilines, and others feed on a provisioned supply of food. The adults, which do not sting, often curl up into a ball when disturbed. They are fairly common and their common names refer to the often bright-red abdomen of many species, and their parasitic and inquiline habits in the nests of solitary bees and wasps.

Chrysidoidea *See* Chrysididae.

Chrysobalanaceae Small family of forest trees and shrubs related to Rosaceae. The flowers are somewhat irregular, and perigynous. The fruit is a drupe. Several yield siliceous timber, others have edible fruit. The coco plum of the West Indies is *Chrysobalanus icaco*. There are 17 genera, comprising about 400 species, with a pantropical distribution.

chrysoberyl Mineral, specific gravity 3.5–3.8, hardness 8.5, and with the chemical composition $BeAl_2O_4$, whose name is derived from the Greek for 'golden-yellow'. It occurs in granites, pegmatites, and mica schists, and also in alluvial sands and gravels. It is distinguished by its colour, hardness, and tabular form. It is various shades of green or greenish-yellow, and has a white streak and a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are normally flat and tabular. The emerald-green variety is used as a gemstone called alexandrite.

Chrysochloridae (golden mole; order Insectivora, suborder Lipotyphla, superfamily Soricoidea) Family of insectivores in which there are no external ears and in which the eyes are covered with skin. The fur has a metallic appearance. The tail is rudimentary. The forelimbs and paws are modified for digging; the second and third digits bear large claws, and the fifth digit is absent. They are distributed in Africa from the equator south. There are five genera, with 11 species.

Chrysocyon brachyurus (maned wolf) *See* Canidae.

Chrysolina menthastri (green mint beetle) *See* Chrysomelidae.

Chrysomelidae (leaf beetles; class Insecta, order Coleoptera) Family of beetles whose members occur in a great variety of shapes and sizes, from 1.5 to 22 mm, but usually they are robust, compact beetles with smooth, brightly-coloured, or metallic elytra. *Chrysolina menthastri*, the conspicuous green mint beetle, is typical. Larvae are grub-like, often coloured, and have short legs; all are plant feeders. Tortoise beetles have expanded sides to the body, giving a flat, shell-like appearance; the larvae conceal themselves with cast skins and faeces. Many chrysomelids are pests. Flea beetles, adults and larvae, 'graze' on upper leaf surfaces; adults, which have enlarged hind femora, are able to spring. Larval juices of some tropical species (poison beetles) are used to tip arrows by Kalahari Bushmen. *Leptinotarsa decemlineata* (Colorado beetle) attacks potato plants, most of the damage being caused by the spread of plant diseases. There are 20 000 species.

Chrysophyceae (golden-brown algae) Class of predominantly unicellular algae in which the chloroplasts contain large amounts of the pigment fucoxanthin, giving the algae their brown colour. Many are flagellated, having one flagellum of the tinsel type, with or without a second flagellum of the whiplash type. Cysts or resting spores are formed which are often characteristically ornamented with spines, etc.; the cyst walls contain silica. Chrysophyceae are found mainly in freshwater habitats that are low in calcium.

Chrysophyllum (family Sapotaceae) Genus of plants which includes *C. cainito*, the star apple of the W. Indies, grown widely for its edible fruits. There are 60 species, occurring in the tropics and subtropics.

Chrysopidae (green lacewings; subclass Pterygota, order Neuroptera) Family of insects which have pale-green bodies; iridescent, often greenish wings; and prominent, reddish-golden eyes. The eggs are laid on foliage at the end of tiny stalks, and the larvae are highly predacious on aphids and plant lice, which they suck out with their hollowed, sickle-shaped mandibles. The larvae often camouflage themselves with the empty skins of their prey and small plant fragments. Pupation occurs in a small, round, silk cocoon. Green lacewings are common insects, found on grass, shrubs, and weeds, and often give off an offensive odour when handled.

Chukrasia (family Meliaceae) Genus of deciduous trees in which the leaves are pinnate. The flowers are large, the stamens wholly fused. The fruit is a capsule. They yield valuable timber (chickrassy, and yom hin). There are one or two species, occurring in India, and from S. China to Malesia.

Chunga *See* Cariamidae.

chusan palm (*Trachycarpus fortunei*) *See Trachycarpus*.

chymotrypsin Peptidase enzyme found in the small intestine that acts on the interior peptide bonds of proteins.

Chytridiaceae (order Chytridiales) Family of fungi in which zoospores are released from the sporangium via an opening previously covered by a lid or operculum. The thallus is monocentric. Species are parasitic or saprotrophic on freshwater and marine algae, fungi, and protozoa.

Chytridiales (class Chytridiomycetes) Order of microscopic fungi which rarely form a vegetative mycelium. Most species are aquatic saprotrophs or parasites, but some are important pathogens of terrestrial plants.

Chytridiomycetes (subdivision Mastigomycotina) Class of small to microscopic fungi, found in fresh water as parasites of algae and invertebrates, or in terrestrial habitats as parasites of plants, as saprotrophs in soil, etc.

Cibotum *See* Thyrsopteridaceae.

cicadas *See* Cicadidae.

Cicadellidae (leafhoppers; order Hemiptera, suborder Homoptera) Family of homopterans which occur on almost every kind of herbaceous and woody plant. Many of them are serious pests of crops which they damage either directly through feeding on the sap or cell contents, or indirectly through the effects of toxic saliva, or by transmitting virus diseases. There are many thousands of species, distributed worldwide.

Cicadidae (cicadas; order Hemiptera, suborder Homoptera) Family of large homopterans in which the nymphs live underground, burrowing with the aid of crab-like forelegs, and feeding on the sap of roots. Adults live in trees, and the males produce a loud 'song'. The life cycle may occupy several years and one well-known species in the USA spends 17 years underground. The nymphs of this species, like some others, construct 'chimneys' of earth above their burrows in which to complete the final moult. There are about 2000 species, occurring mainly in the tropics.

Cicca (family Euphorbiaceae) Genus of one species, *C. acida*, a small tropical fruit tree which is widely cultivated, and which is probably native to NE Brazil. Its leafy twigs resemble pinnate leaves. The fruit is an acid, pulpy berry.

Cichlidae (cichlids; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of freshwater fish, many of which are rather deep-bodied. They have a single, continuous dorsal fin which can be very high (e.g. in *Pterophyllum* species, angelfish) or low (e.g. in *Symphysodon* species, discus fish). The lateral line is interrupted and there is a single pair of nostrils. Cichlids vary in size: *Apistogramma ramirezi* (butterfly cichlid) does not exceed 6 cm, but other species, e.g. *Sarotherodon aureus* grow to 35 cm. A large number of cichlids are being cultivated to satisfy the demands of aquarium hobbyists as these fish are colourful, fairly easy to keep, and show interesting behavioural traits. Other species of the genera *Tilapia* and *Sarotherodon*, e.g. *S. mossambicus*, are a very important source of protein in many countries. There are probably at least 700 species: most occur

in Africa, but they are also found in S. America, India, and parts of the Middle East. *See also* buccal incubation.

cichlids *See* Cichlidae.

Cichorium (family Compositae) Genus of perennial herbs with alternate leaves, and flower heads of blue, strap-shaped florets. The achenes are angled, with blunt scales on top. The roots of *C. intybus* (chicory) are used for blending with coffee; *C. endivia endivia* (endive) is used as a vegetable. There are nine species occurring in the Mediterranean region, one reaching N. Europe, and one in Ethiopia.

Cichorium endivia endivia (endive) *See Cichorium*.

Cichorium intybus (chicory) *See Cichorium*.

Cicindella (tiger beetle) *See* Carabidae.

Ciconia (storks; family Ciconiiformes) Genus of medium to large black and white storks with a ruff of feathers on the lower foreneck. They are found in open country, where they feed on animal matter, and breed mainly in trees; *C. ciconia* (white stork) often breeds on nest platforms on buildings. Many of these birds are highly migratory. There are five species, found in Europe, Africa, Asia, and S. America.

Ciconia ciconia (white stork) *See Ciconia*.

Ciconiidae (storks; order Ciconiiformes) Family of large wading birds with stout-based bills and long necks, some with distensible throat pouches and bare faces, heads, or necks. They have long, broad wings, and long legs with semipalmate toes. They are found in open, often wet, country, frequently breeding colonially in trees. There are six genera, with 17 species, found nearly worldwide. *See also* primaries.

Ciconiiformes (herons, storks, ibises, spoonbills, flamingos; class Aves) Order of medium to large wading birds, many with specialized bills. Their toes are unwebbed or partially webbed and the middle claw is often pectinate. There are six families: Ardeidae, Cochleariidae, Balaenicipitidae, Ciconiidae, Threskiornithidae, and Phoenicopteridae. They are found worldwide.

Cidaroida (subclass Perischoechinoidea) Order of regular echinoids with a radially symmetrical, subspherical test. The ambulacra are in two columns, with each plate bearing a single pore pair. The interambulacra are conspicuously wider than the ambulacra, each plate bearing one enlarged primary tubercle carrying a primary spine. The teeth are not keeled. There are no gill slits or sphaeridia. Cidaroida first appeared in the Upper Silurian. There are six subfamilies, within two families, extant.

cider sickness Condition of cider that has become contaminated with the bacterium *Zymomonas anaerobia*. The bacterium produces acetaldehyde which spoils the flavour of the cider.

ciguatera Type of poisoning caused by eating the flesh of affected fish. The symptoms include nausea, vomiting, numbness of parts of the body, and even coma. The substance ciguatoxin is probably obtained initially from blue-green marine plants eaten by small fish, in turn eaten by larger fish in which the toxin accumulates. Sometimes, therefore, it is probably wise not to eat certain species (e.g. mackerel, grouper, jack, and snapper).

cilia *See* cilium.

Ciliatea (subphylum Ciliophora) Class of protozoa with the characteristics of the subphylum. The class contains four subclasses, many orders, and numerous genera.

Ciliophora (phylum Protozoa) Subphylum of protozoa in which cilia are present during at least one stage of the life cycle, and in which two different types of nucleus, macronucleus and micronucleus, are normally present. Cells reproduce by binary fission. Sexual processes occur. Most species are free-living, although some are parasitic. There is one class.

cilium (pl. cilia) Short, hair-like appendage, normally 2–10 μm long and about 0.5 μm in diameter, usually found in large numbers on those cells that have any at all. Cilia have a microtubular skeletal structure enclosed by an extension of the plasma membrane. The microtubules are arranged in nine sets of doublets around the circumference, with two single tubules in the centre, the so-called '9 + 2' construction. In certain protozoa, cilia function in locomotion and/or feeding. They generate currents in the fluid surrounding the cell by beating in a co-ordinated manner.

Cimbicidae (suborder Symphyta, superfamily Tenthredinoidea) Family of moderate- to large-sized (18–25 mm long) symphytans which resemble hairless bumblebees. The antennae possess seven or fewer segments and are slightly clubbed. The larvae feed on elm, willow, poplar, hawthorn, etc. and can be serious pests of trees. They may be recognized by their greenish-yellow colouring, with black spiracles and a dorsal stripe. The larvae of many species can eject an offensive secretion from glands just above the spiracles. Cimbicidae occur in Europe and N. America.

Cimex lectularius (bedbug; family Cimicidae) Insect in which adults and nymphs are nocturnal, coming out of concealment to suck blood from the capillaries of their hosts, which include humans and many domesticated animals and birds. The bedbug is a pest of dwellings and animal-houses, but is not known to transmit any disease.

Cimicidae (order Hemiptera, suborder Heteroptera) Family of bugs comprising several dozen flightless forms which suck the blood of birds and mammals, especially bats (*see Cimex lectularius;* and *Oeciacus hirundinis*), and a few hundred species that are predators of other small arthropods. A few feed on pollen. They occur in all parts of the world.

Cinchona (family Rubiaceae) Genus of trees, several species of which were formerly widely cultivated for quinine and related drugs, contained in the bark. There are 40 species, native to the Andes.

Cinclidae (dippers; order Passeriformes) Family of brown, grey, or black thrush-like birds with white on the head or under-parts. They have short tails; long, stout legs; and dense, waterproof plumage. They are found by swift streams: they build a domed nest with a side entrance in a hollow near a stream, and feed on aquatic larvae, crustacea, and fish, taken underwater. They swim well and walk under water. There is one genus, *Cinclus*, with five species, found in Europe, N. Africa, Asia, and N., C., and S. America.

Cinclus *See* Cinclidae.

cinder cone Volcanic cone built of pyroclastic material (cinders and scoriaceous ejecta) usually of basaltic or andesitic composition, dominated by fragments 2–64 mm diameter. These air-fall deposits build a straight-sided cone with slopes of about 30° (the angle of repose). Complex varieties may occur, including breached or gaping, and cone-within-cone types.

cinders 1 Obsolete term for medium-grained tephra. 2 Partly-smelted iron ore, used for re-smelting.

Cingulata (order Edentata, suborder Xenarthra) Infra-order comprising one extinct (Glyptodontoidea) and one extant (Dasypodoidea) superfamily of armadillo-like animals, distinguished by their banding from the furred ant-eaters and sloths to which they are related.

cinnabar The commonest mercury mineral, specific gravity 8.0–8.2, hardness 2.0–2.5, chemical composition HgS, which occurs in sedimentary rocks in fractures in areas of volcanic activity, and around hot springs. It is associated with pyrite, stibnite, and realgar, and is distinguished by its red colour and streak, and its high specific gravity. It is scarlet-red to brownish-red, and its streak is vermilion; and it has an adamantine lustre. It crystallizes in the trigonal system. The crystals are rhombohedral or thick, tabular plates, but they can be massive or granular. It is the only major ore for mercury metal.

Cinnamomum (family Lauraceae) Genus of trees in which the leaves are opposite, and spicy when crushed. The fruit is a berry contained in a cup-like perianth. The spice cinnamon is the bark mainly of *C. zeylanicum*. Camphor is obtained by distillation of the wood of *C. camphora*. There are 250 species, occurring in E. and SE Asia.

cinnamon *See Cinnamomum*.

circadian rhythm Diurnal pattern of various metabolic activities seen in all organisms. The rhythmic patterns may persist even when the organism is removed from exposure to 24-hour cycles of light and dark. They are thought to be controlled by an endogenous biological clock, though little is known about the sites and modes of action of the mechanisms involved.

circalittoral zone The area of the continental shelf sea-bed that lies below the zone of periodic tidal exposure. It is approximately equivalent to the sublittoral zone. *Compare* mediolittoral; and infralittoral; *see also* littoral zone.

circinate *See* vernation.

circle of vegetation The highest classificatory unit used by the Zurich–Montpellier school of phytosociology, this refers to a definite geographical region with a distinctive floristic element. This approximates to a major plant geographical region.

circumaustral distribution The distribution pattern of organisms found around the high latitudes of the southern hemisphere in the austral region, i.e. next to the antarctic zone. An example of such a pattern is provided by the southern species of *Danthonia* (poverty grasses and wild-oat grasses).

circumboreal distribution The distribution pattern displayed by organisms around the high latitudes of the northern hemisphere in the boreal zone. The boreal zone lies next to the arctic zone, and many circumboreal organisms are in fact also circumarctic. An example of a plant with both types of distribution is *Saxifraga oppositifolia* (purple saxifrage).

circumnutation The spiral movement of a shoot apex as it grows.

circumpolar distribution Denotes the range of organisms distributed around the North or South Pole. Strictly the term should be reserved for organisms that extend into the polar regions. *Eutrema edwardsii* (Edwards's eutrema) is a good example of a flowering plant with such a distribution around the North Pole; an animal example is the reindeer or caribou (*Rangifer tarandus*).

circumtropical fish Fish species which are found in all the warm to temperate waters of the world. Some of these species (e.g. *Galeocerda cuvieri*, tiger shark, and *Coryphaena hippurus*, dolphinfish), may undertake extensive migrations.

Circus (harriers; family Accipitridae) Genus of medium-sized hawks with long slender wings and long tails. Males are generally grey, and females are larger and brown. They have small bills and owl-like heads. They are found in marshy areas and open plains; and feed on small mammals, frogs, and birds, quartering the ground with their wings typically held in a shallow 'V'. They are usually ground-nesting. Some are migratory. There are 10 species, found nearly worldwide. *See also* Accipitridae.

cirque (corrie, cwm) Half-open, steep-sided hollow in a mountain region that has been or is being glaciated. Its form is due to a combination of glacial scouring (which deepens the floor and often produces a reversed long-profile gradient), and gelifraction (which acts on the cirque's head and side walls).

Cirrhitidae (hawkfish; cass Osteichthyes, subclass Actinopterygii, order Perciformes) Family of fairly small marine fish with a robust body, a rounded tail-fin, and tiny frills (cirri) at the tips of the spines of the first dorsal fin. Living among rocks or reefs, the brown-spotted skin makes these fish hard to see. One of the larger species, *Cirrhitus alternatus* of Hawaii, grows to at least 25 cm. Although widely distributed in tropical seas, most species are found

in the Indo-Pacific region. There are about 35 species.

Cirrhitus alternatus (hawkfish) *See* Cirrhitidae.

cirri Plural of cirrus. *See also* Cirripedia.

Cirripedia (barnacles; phylum Arthropoda, subphylum Crustacea) The only class of crustaceans, apart from parasitic groups, in which the adults are wholly sessile. Cirripedes are the familiar barnacles that settle on rocks, submerged timbers, corals, shells, and the undersides of ships. The 900 or so described species are entirely marine. Cirripedes have free-swimming larvae, the last of which is called a cypris larva. This resembles an ostracod, in that the body is entirely enclosed by a bivalved carapace. It settles on the substrate and becomes attached by means of cement secreted from basal glands in the first antennae. The larval carapace persists and in adult barnacles is often termed the mantle. In the common barnacles (order Thoracica) calcareous plates develop and cover the mantle externally, and there are both stalked and sessile groups. Except for the cement glands, the first antennae are vestigial, and the second antennae are present only in the larvae. Typically, there are six pairs of long, biramous, thoracic feeding appendages (cirri) which are projected through the mantle opening to scoop up plankton. The body comprises a cephalic region and an anterior trunk (or thoracic region), with very little indication of external segmentation. Apart from the typical 'barnacle' type, there are forms (order Acrothoracica) modified for boring into shells and corals, and naked forms (orders Ascothoracica and Rhizocephala) which parasitize other marine organisms.

cirrocumulus Cloud type comprising shallow, high-level cloud in stable air. The form is sheeted or layered with small-scale billows, or ripples. As freezing of the supercooled droplets of young clouds occurs, so the fine-patterned features of the cloud become more diffuse. *See also* cloud classification.

cirrostratus Cloud type comprising a semi-transparent veil of fibrous or smooth appearance, often covering the sky, and identified by halo phenomena. When associated with a cold front, the cloud sheets have distinct edges. *See* also cloud classification.

cirrum In many invertebrates, a slender appendage resembling a tentacle.

cirrus **1** (meteorol.) From the Latin *cirrus*, meaning a tuft or lock of hair, a cloud type comprising high-level, banded clouds in fibrous filaments aligned approximately along their line of movement. *See also* cloud classification. **2** (protozool.) In certain ciliate protozoa, an organelle formed by the fusion of a group of cilia, which usually functions in locomotion. **3** (bot.) *See Calamus; Ceratolobus;* and *Daemonorops*. **4** (zool.) *See* Cirripedia.

Cistaceae Family mostly of low shrubs but also of a few herbs, in which the leaves are usually opposite. The flowers are regular and bisexual; and with either five unequal or three equal sepals, and five crinkled, showy petals. There are many stamens. Usually the ovary is one-celled, and contains many seeds. The style is simple, the fruit a capsule. *Cistus* species (which have a five-valved capsule) are much cultivated for their large flowers, as are some *Helianthemum* species (which have a three-valved capsule). There are eight genera, with about 170 species, centred in the Mediterranean region, but extending through Europe, central Asia, and America.

cisternae Large, flattened, membranaceous sacs that occur in a number of cell organelles, e.g. in the Golgi body, and in the endoplasmic reticulum.

Cisticola (cisticolas; family Sylviidae) Genus of small, brown, striped warblers with tails varying from very short to long. They are found in scrub, grassland, and reed beds. They feed on insects, and build intricate, enclosed nests in bushes and grass. There are about 41 species found in Europe, Africa, and from S. and SE Asia to New Guinea and Australia.

cisticolas *See Cisticola*.

Cistothorus (marsh wrens; family Troglodytidae) Genus of small brown wrens with streaked backs. They are found in marshes and grassland, feeding on insects and building a domed nest in grass or bushes. There are four species, found in N., C., and S. America.

***cis–trans* test** *See* complementation test.

cistron Section of the DNA molecule that specifies the formation of one polypeptide chain. A *cis–trans* test is performed to determine whether two mutant sites of a gene are in the same cistron or in different ones. In the *cis* configuration, both mutants are on one homologous chromosome and both wild-types are on the other ($a^1a^2/++$), producing a wild-type phenotype. In the *trans* configuration each homologue has a mutant and a non-mutant (a^1+/a^2+), producing a mutant phenotype.

Cistus *See* Cistaceae.

Citharidae (class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Small family of marine flatfish, with short pelvic-fin bases, these fins carrying one spine and five soft rays. In *Citharus* and *Citharoides* the eyes are on the left side of the body, but in *Brachypleura* and *Lepidoblepharon* the eyes are on the right side. Citharidae occur in the Mediterranean and Indo-Pacific regions.

Citharinidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish with a very deep body, relatively small head, forked tail-fin, large dorsal fin, and small adipose fin near the tail. They are found in the rivers of central Africa. *See also* Diodontidae.

Citharoides *See* Citharidae.

Citharus *See* Citharidae.

citric-acid cycle (Krebs cycle, tricarboxylic-acid cycle) Cyclic series of reactions which represents the principal means by which most living cells provide electrons for the generation of ATP via the

electron-transport chain and oxidative phosphorylation. The sequence is initiated by the condensation of acetyl coenzyme A with oxaloacetic acid to form citric acid. This then passes through a series of reactions wherein oxaloacetic acid is reformed, and 2 moles of CO_2 and water and 12 moles of ATP are synthesized.

citrine *See* quartz.

Citrus (family Rutaceae) Genus of plants, many of which are in cultivation for their fruit—sweet orange is *C. sinensis*, sour orange *C. aurantium*, grapefruit *C. paradisi*, lemon *C. limon*, lime *C. aurantifolia*, and there are others. The leaves are simple, the stalk often winged. The fruit is a hesperidium. There are about 16 species, occurring from SE Asia to New Caledonia.

civet *See* Viverridae.

Cixiidae (order Hemiptera, suborder Homoptera) Family of homopterans which resemble small cicadas in the adult state. The nymphs feed on plants at or below the ground surface, but the adults live in most exposed situations. There are about 1000 species, distributed worldwide.

Cl *See* chlorine.

clade Term derived from the Greek *klados*, a twig or branch. In cladistics, or phylogenetic systematics, it refers to a lineage branch that results from splitting in an earlier lineage. A split produces two distinct new taxa, each of which is represented as a clade, or branch in a phylogenetic diagram.

Cladista (Cladistia) Older name for either the order Polypteriformes or the subclass Brachiopterygii.

cladistics (phylogenetic systematics) Special taxonomic system applied to the study of evolutionary relationships. In the branching diagrams or 'cladograms' used to portray these relationships, cladogenesis, or splitting of an evolutionary lineage, always creates two equal sister taxa: the branching is dichotomous. Thus each pair of sister taxa constitutes a monophyletic group with a common stem taxon, unique to the group.

Cladium (family Cyperaceae, tribe Rhynchosporoideae) Genus of rhizomatous herbs which have smooth, leafy stems. The leaves are long and linear, a number of them arising at the base of the stem. The flowers are bisexual, or sometimes the upper or lower are male. There is no perianth; there are two or three stamens and the same number of stigmas. The ovary is superior and unilocular, with two or three fused carpels. The fruit is a globular or trigonous nut with much endosperm. There are about 50 species, found in tropical and temperate marshy regions, especially in Australasia. *C. mariscus* (saw sedge) is used for thatch in Europe, and other species are used in basket-work and paper-making.

Cladium mariscus (saw sedge) *See Cladium*.

Cladocera (water fleas; phylum Arthropoda, subphylum Crustacea, class Branchipoda, order Diplostraca) Suborder of branchiopod Crustacea in which the carapace encloses the trunk but not the head. The strongly biramous second antennae are the sole means of a rather jerky locomotion, the trunk appendages being reduced to five or six pairs, at least some of which bear food-filtering setae. The postabdomen is bent ventrally and forward, and bears claws and spines modified for cleaning the carapace. Many cladocerans undergo seasonal changes in shape, called cyclomorphosis. Cladocera are important food for many freshwater invertebrates and fish, and one genus, *Daphnia*, is sold commercially as food for aquarium fish. There are 425 species.

Cladochytriaceae (order Chytridiales) Family of fungi in which only part of the thallus differentiates to form reproductive structures. The vegetative part of the thallus consists of a system of branching threads called a rhizomycelium. Species are found on decaying plant material or as parasites on algae, etc.

Cladodontiformes (class Chondrichthyes, subclass Elasmobranchii) Order of fossil sharks with an elongate body, and one dorsal fin without a spine, which lived during the Middle Devonian and Carboniferous.

cladogenesis Cladistics views the development of each new taxon as a result of the splitting of an ancestral lineage to create two equal sister taxa, taxonomically separated from the ancestral taxon. This branching into derivative taxa is known as cladogenesis. *See also* adaptive radiation.

cladogram Diagram that delineates the branching sequences in an evolutionary tree.

Cladonia (family Cladoniaceae) Genus of lichens in which the thallus usually consists of a crustose or squamulose primary thallus (which may be evanescent), and a fruticose secondary thallus called a podetium. Podetia may be erect, and branched or unbranched, or may be shaped like miniature cups or wine glasses. Apothecia, when present, are borne at the tips of the branches, or on the edges of the cups, and may be red or brown. *Cladonia* is a large genus consisting of over 300 species, found on the ground, on rocks, on wood, etc.

Cladoniaceae (order Lecanorales) Family of lichens in which there is a primary thallus which may be crustose or squamulose (sometimes evanescent), and from which arise erect, solid or hollow, simple or branched podetia, upon which are borne the apothecia. Spores are aseptate. There are several genera, found mainly on the ground on acid soils, but also on other substrates.

Cladophorales (class Chlorophyceae) Order of filamentous green algae in which the cells are multinucleate. Species of the genus *Cladophora* are common. They form long, tangled, rough-textured skeins ('blanket weed'), usually attached to rocks, in standing or running fresh water; they may be a troublesome weed in garden ponds. Some species are marine, growing—often abundantly—on rocks on the lower shore, and in rock pools.

Cladoselache Late Devonian, shark-like fish recorded from Europe and N. America. *Cladoselache* ranged between 0.5 and 1.2 m in length and is noted for the presence of a large ventral fin.

Numerous specimens of this genus have been collected from the Cleveland Shales, Upper Devonian, in N. America.

Cladoselachiformes (class Chondrichthyes, subclass Elasmobranchii) Order of fossil sharks with an elongate body, the two dorsal fins each with a spine, e.g. *Cladoselache*. They lived from the Devonian to the Carboniferous.

Cladosporium (class Hyphomycetes) Form-genus of fungi which form septate mycelium, and chains of dark-coloured conidia. They are saprotrophic, or parasitic in plants, sometimes causing disease. *C. resinae* has a perfect state classified in the Ascomycotina. *See also* creosote fungus.

Clamator (cuckoos; family Cuculidae) Genus of large, mainly black and white, crested cuckoos found in forest and scrub. They are insectivorous and brood-parasitic. *C. glandarius* (great spotted cuckoo) parasitizes crows and starlings. *Clamator* species are migratory. There are four species, found in Europe, Africa, and S. Asia.

Clamator glandarius (great spotted cuckoo) *See Clamator*.

clamp connection In certain types of fungi, a bulge on one side of a dikaryotic hypha at the site of a septum. It is formed during cell division, as a result of a mechanism that ensures maintenance of the dikaryotic state.

clam shrimp *See* Conchostraca.

Clan-William cedar (*Widdringtonia juniperoides*) *See Widdringtonia*.

clapboard Timber used for cooperage (barrel-making), made usually from oak, and for cladding buildings.

Clarias batrachus (walking catfish) *See* Clariidae.

Clarias mossambicus *See* Clariidae.

Clariidae (air-breathing catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of freshwater catfish with elongate to eel-shaped bodies. The head carries four pairs of barbels; both dorsal and anal fins are very long and spineless, the tail-fin is rounded. Typically clariids have a labyrinthic organ above the gill arches used as an accessory air-breathing structure. *Clarias batrachus* (walking catfish) can move over land for short distances. Introduced into the southern USA from SE Asia, this species may constitute a threat to native American fish. One of the larger species, *Clarias mossambicus*, grows to 1.2 m and is known to survive in poorly oxygenated African freshwater systems. There are about 100 species, found in Africa and tropical Asia. *See also* accessory respiratory organs; and air breathing in fish.

claspers The pelvic fins of male sharks and rays, modified to serve as copulatory organs.

classification method Any scheme for structuring data that is used to group individuals, or sometimes attributes (*see* normal analysis, and inverse analysis). In ecological and taxonomic studies especially, quite sophisticated numerical classification schemes have been devised, and an extensive theoretical literature exists relating to them. The methods developed in these disciplines are being applied increasingly in other fields, notably pedology and palaeontology. Various classificatory strategies may be used, e.g. hierarchical or non-hierarchical; and where hierarchical schemes are used, these may be divisive or agglomerative, and monothetic or polythetic, with the divisive polythetic approach being considered the optimum strategy. *Compare* ordination methods.

clast *See* clastic rock.

clastic Applied to the texture of fragmental sedimentary rocks.

clastic rock Sediment composed of fragments of broken sedimentary rocks (clasts). These fragments may vary in size from boulders to silt-size grains, and are invariably the products of erosion followed by deposition in a new setting. Consolidated clastic rocks include conglomerates, sandstones, and shales.

Clathrinida (class Calcarea, subclass Calcinea) Order of sponges whose body possesses an ascon structure. There is no cortex or dermis.

Clavaria (family Clavariaceae) Genus of fungi in which the hymenium is borne on the surface of cylindrical or club-shaped fruit bodies. *C. vermicularis* forms clusters of white, pointed, cylindrical fruit bodies in grassy places. *C. fumosa* is similar, but yellowish-grey in colour. *C. argillacea* forms club-shaped, unbranched, whitish fruit bodies on mossy, peaty ground, and is common in summer and autumn.

Clavariaceae (order Aphyllophorales) Family of fungi in which the fruit bodies are erect, branched or unbranched, cylindrical or club-shaped. Spores are produced on the surface of the fruit body. There are many genera, found chiefly on the ground, or on rotting wood. *See also* fairy club.

clavate Club-shaped; thicker toward one end.

Claviceps (family Clavicipitaceae) Genus of plant-parasitic fungi which includes the causal agent of ergot, *C. purpurea*. This species forms elongated, curved, purple sclerotia which replace the grain in an infected host plant. A wide range of grasses and cereals can be affected.

Clavicipitaceae (order Sphaeriales) Family of fungi which form perithecia in a fleshy stroma; the ascospores are long and narrow. There are many genera, most of them parasitic on grasses, sometimes causing important plant diseases. Some are parasitic in insects.

clavicle In many vertebrates, a bone on the ventral side of the shoulder girdle. In humans it is commonly called the collar bone.

Clavulina (family Clavulinaceae, order Aphyllophorales) Genus of fungi in which the hymenium is borne on the surface of small, club-shaped fruit bodies. The basidia bear two spores rather than the usual four. *C. cristata* forms brittle, white, irregularly branched fruit bodies 3–8 cm tall. It is common on the ground in broad-leaved woods. *C. rugosa* is similar but is longitudinally wrinkled, and less extensively branched.

clawed frog *See Xenopus laevis.*

clawed toad *See Xenopus laevis.*

clay 1 Soil separate comprising mineral particles less than 2 μm in diameter. 2 Class of soil texture, usually containing at least 20% by weight of clay particles. *Compare* clay mineral.

clay films *See* cutan.

clay mineral Member of a group of chemically-related hydrous aluminium silicates, which generally occur either as very small platy or fibrous crystals. They have a layered structure and the ability to take up and lose water readily. It is difficult to distinguish various clay minerals, and therefore geologists employ sophisticated techniques, e.g. X-ray diffraction analysis and electron microscopy. The most important clay minerals belong to the kaolinite, hydrous mica, smectite, chlorite, vermiculite, and talc groups.

clay pan *See* pan.

clayskins *See* cutan.

cleaner fish Fish that remove ectoparasites from other fish (which usually are much larger in size). Cleaner fish have conspicuous colour markings which make them easily recognizable to their temporary 'host'. This allows the cleaner fish (e.g. the cleaner wrasse *Labroides dimidiatus*) to come close with little risk of being eaten.

cleaner wrasse (*Labroides dimidiatus*) *See* cleaner fish; and Labridae.

clear-air turbulence (CAT) The variable pattern of up- and down-draughts, or turbulence, sometimes occurring in the absence of any cloud. It is caused by strong wind shear, especially associated with jet streams in the upper troposphere and lower stratosphere. The phenomenon is significant for aircraft.

clear fell Clear an area of woodland or a whole woodland of trees completely, but not necessarily permanently.

clear ice (glaze) Layer of transparent ice formed on objects near the ground, or on aircraft in flight, by freezing rain.

clearwings *See* Sesiidae.

cleavage 1 In minerals, cleavage is evident when crystals split along planes of weaknesses inherent in the structure of their atomic lattices. Rocks also fracture along closely-spaced planar structures if deformed or metamorphosed. This tendency to cleave is evident in slates due to the parallel arrangement of mica. With deformation, a second cleavage may be superimposed across an original slaty cleavage, so that a crenulation cleavage cuts across the older foliation. 2 (segmentation) Process by which a dividing egg-cell, following fertilization, gives rise to all the cells of the organism. In animals, this division forms a cellular mass called a blastula. If cleavage follows a definite pattern it is said to be determinate (and hence permits the tracing of cell lineages). In some species, however, the pattern is lost after the first few cell divisions.

cleavers (*Galium aparine*) *See Galium.*

clegs *See* Tabanidae.

cleistocarp *See* cleistothecium.

cleistothecium (cleistocarp) Ascocarp in which the asci are enclosed completely. Ascospores are released only on rupture of the wall of the cleistothecium.

Clematis (family Ranunculaceae) Anomalous genus in the family, of plants which have a woody, liane habit, and opposite compound leaves whose stalks or tendrils twine to support the climbing plants. The flowers usually have four petaloid perianth segments, and long, plumed styles that aid in the wind dispersal of achenes. There are about 250 species, most in the northern temperate zone; many are cultivated for their flowers or foliage.

Cleptidae (suborder Apocrita, superfamily Bethyloidea) Family of wasps which parasitize the prepupae of symphytans and the eggs of Phasmatodea. Marked sexual dimorphism occurs, the males being fully winged but not active; the females, which are seldom seen, often being brachypterous, with their forewings much reduced.

Cleridae (chequered beetles; class Insecta, order Coleoptera) Family of elongate, soft-bodied, pubescent beetles, up to 40 mm. Usually they are brightly coloured, but some are cryptic. The antennae are short, and loosely clubbed. They often occur in woodland where they prey upon adult bark beetles (Scolytidae). The larvae are cylindrical and coloured blue, pink, or orange, and feed on bark-beetle larvae. *Necrobia rufipes*, blue-green as an adult, occurs worldwide as a pest of stored meat products. Some *Trichodes* species feed on bee larvae. There are 3400 species, mostly tropical.

Clerodendron *See* Verbenaceae.

Clethraceae Family of shrubs or trees, closely related to the Ericaceae, which have simple, alternate leaves. The fragrant flowers have a bell-like, persistent calyx; five free, imbricate petals; 10–12 free stamens; anthers with apical pores; and a superior, three-celled ovary. The fruit is a capsule. There is one genus, occurring in tropical to warm-temperate America, E. Asia, and Madeira.

Clianthus (family Papilionaceae, tribe Galegeae) Genus of legumes bearing large, red, pea-like flowers on erect peduncles and with soft, grey stems and leaves. *C. formosus* (Sturt's desert pea) is the emblem of the state of S. Australia. It grows rapidly in dry regions following rain and forms a scrambling plant up to 2 m high. The genus comprises two species, one found in Australia and the other in New Zealand.

Clianthus formosus (Sturt's desert pea) *See Clianthus.*

click-beetle *See* Elateridae.

cliff frogs *See* Leptodactylidae.

Cliftonia monophylla (buckwheat tree) *See* Cyrillaceae.

climacteric The phase of increased respiration found at the ripening of fruit and at senescence.

Climacteridae (Australian tree-creepers; order Passeriformes) Family of small, brown birds with slightly decurved bills and large feet and claws. They are found in forest and scrub and are mainly insectivorous, feeding in an upward spiral on tree trunks, and occasionally on the ground. They nest in a hollow branch or trunk. Members of a monotypic genus, *Climacteris*, are found in Australia and New Guinea.

Climacteris *See* Climacteridae.

climate classification The grouping of climates into broad types according to their shared characteristics. There are three principal approaches to the task. (a) Generic classification is based on levels of temperature and aridity as these relate to vegetation boundaries. Aridity is usually expressed as 'effective precipitation', which is calculated as the ratio of rainfall to temperature. Climatic types are defined by the floral response to them. The Köppen system, with its modifications, uses this approach. (b) Classifications based on the moisture budget and 'potential evapotranspiration' (i.e. the maximum moisture that will be transferred from the ground to the atmosphere, provided that sufficient moisture is available) do not rely on vegetation boundaries. The Thornthwaite system uses this approach. (c) Genetic classification, based on factors related to the atmospheric circulation of major winds and air masses, and on other factors that cause climate, is used in the systems of H. Flohn (1950) and A. N. Strahler. *See also* Köppen climate classification; Strahler climate classification; and Thornthwaite climate classification.

climatic climax Plant community that is in equilibrium with a zonal climate. *See also* climax theory.

climatic optimum Period of highest prevailing temperatures since the last ice age, in most parts of the world about 4000–8000 years ago.

climatic station Place where the basic climatic elements are regularly observed and recorded.

climatic zone Region or zone characterized by generally consistent climate. Climatic zones approximate to distinct latitude belts around the Earth. The principal ones are the humid tropical, subtropical arid and semi-arid, humid temperate, boreal (northern hemisphere) or sub-arctic/sub-antarctic, and polar zones.

Climatiiformes One of the larger orders of fossil fish belonging to the class Acanthodii. They possessed bony jaws and body skeleton, ganoid scales, a heterocercal tail, and stout spines located before the dorsal, anal, pectoral, and pelvic fins. One of the better-known forms, *Climatius*, carried five additional pairs of fins along the belly and reached a length of only 8 cm. These 'spiny sharks' may actually be half-way between the sharks and the bony fish.

climax adaptation number Value, in the range 1–10, assigned to species in the Wisconsin ordination scheme and based on the species' importance values. Stands with the same leading dominants are grouped together, and importance values for all species in the group are recalculated. By comparing the changing importance of species in groups with different leading dominants, the leading dominants and then other species can be placed in phytosociological order. *See also* importance value; and density-frequency-dominance.

climax community (climax vegetation) The final stage of a plant succession, in which vegetation reaches a state of equilibrium with the environment. The community is more or less self-perpetuating; any change that occurs is very slow and takes place over a time-scale that is extensive compared with the rapid and dramatic changes during the early stages of succession. *See also* climax theory.

climax theory Theory that embraces the idea of successional development to an optimum sustainable vegetation community that is in equilibrium with its environment. Two conceptual models of climax vegetation exist: monoclimax (F. E. Clements, 1904, 1916) and polyclimax (A. G. Tansley, 1916, 1920). The essential difference between them lies in the time-scale envisaged for the development of the climax. Monoclimax envisages the development of vegetation and soil toward a definite end-point controlled by climate. Many ecologists consider this approach unworkable in practice, since equilibrium can never be reached owing to variations in climate over long periods of time (e.g. the known climatic changes in historical and post-glacial times in mid-latitudes). Evidence from climatically relatively uniform and stable tropical areas shows different, equally persistent, woodland communities edaphically controlled. Insistence on a single uniform climax community for a major climatic region necessitates the introduction of an extensive terminology for sub-climax communities, so tending to obscure an otherwise useful and simple concept. The alternative—polyclimax—approach proposes successional development to equilibrium with the environment, which may be controlled by climate or by some other factor, e.g. soil or fire, as often occurs in practice. *See also* climax community; and succession.

climax vegetation If a bare surface becomes available for colonization by plants, the vegetation will pass through a succession of so-called seral stages as more complex communities replace the earlier, simpler ones. Ultimately a state of equilibrium or climax is reached, which may reflect predominantly the control of climate, soil, or humans. *See also* climax community; and climax theory.

climbing perch (climbing gourami, *Anabas testudineus*) *See* air breathing in fish; and Anabantidae.

climograph Two-dimensional, graphical representation of one major climatic element against another, e.g. rainfall against temperature. Typically the average values for each month are plotted, and the points joined together sequentially to give a dodecagon of a shape that is characteristic for a particular area. This forms an easily prepared basis for quick visual comparison of the climates of different areas. Uses include the assessment of the

suitability of a new environment for a proposed species introduction.

climosequence Sequence of soil profiles, usually on the same parent material, that differ from each other in their profile development because of local or site differences in climatic conditions. Climosequences can be found along mountain slopes in certain highland areas.

climotope The climatic component of the habitat or ecotope of a biogeocoenosis.

clinal speciation Type of allopatric speciation in which a geographic barrier falls across a cline, cutting a species into two segments which are thus already somewhat different and which can continue to diverge in their new isolation.

cline Gradual change in gene frequencies or character states within a species, across its geographic distribution.

clingfish *See* Gobiesocidae.

Clinidae (scaled blennies; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of marine, mainly tropical fish which differ from the true blennies (Blenniidae) in having fully scaled bodies and slender spines in the long dorsal and anal fins. They are small, bottom-dwelling fish, and occur in inshore situations. One of the larger species is *Clinus superciliosus* (klipfish), of S. Africa, which grows to 30 cm. There are about 175 species, found worldwide.

clinosequence Sequence of soils in which soil-profile development is related to the angle of slope of the soil surface. Clinosequences can be found on land-forms such as escarpments and drumlins with varying surface angles of slope.

clint Joint-bounded surface unit of a hard, almost horizontally-bedded limestone. The diameter varies typically from 1 to 2 m. It may be shallowly dissected by smooth gutters, or runnels. It is a repeating component of a limestone pavement (an extensive bedding-plane surface exposed by erosion).

Clinus superciliosus (klipfish) *See* Clinidae.

Clitocybe (family Tricholomataceae) Genus of fungi which form mushroom-like fruit bodies in which the cap is more or less funnel-shaped, and fleshy. The gills are often decurrent. There are many species, some of which are edible whereas others are extremely poisonous. They are usually found on the ground, especially under trees.

clitter Local term for the gently sloping spread of coarse, angular rock debris surrounding many of the tors of Dartmoor, SW England. It is a result of the frost shattering of the Dartmoor granite during the periglacial phases of the Pleistocene, but the rock is now stable, and largely vegetated.

cloaca Terminal part of the gut into which the alimentary, urinary, and reproductive systems open, leading to a single aperture in the body.

clod Compact, coherent block of soil, found *in situ* when soil is broken up by digging or ploughing. Clods are of varied sizes.

clonal-selection theory Theory of antibody specificity to account for the very great variety of immunoglobins that an organism may produce, and the absence of antibodies that react with the organism's own cells. The theory suggests that during embryonic development a vast population of lymphoid cells is produced, each possessing the ability to synthesize a different antibody. There follows selection by cloning of only those cells that produce antibodies with configurations that are not complementary to any antigens normally present in the embryo.

clone Group of genetically identical cells or individuals, derived from a common ancestor by asexual mitotic division. If a section of DNA is engulfed into the chromosome of a bacterium, phage, or plasmid vector and is replicated to form many copies, each copy is referred to as a DNA clone.

closed canopy Condition in which the crowns or canopies of individual trees overlap to form a virtually continuous layer. *See also* canopy.

closteroviruses Group of elongated and thread-like, RNA-containing viruses which can, as a group, infect a wide range of plants, including monocotyledons and dicotyledons. Most closteroviruses are transmitted from plant to plant by aphid vectors. Some can cause diseases of considerable economic importance.

Clostridium (family Bacillaceae) Genus of bacteria in which the cells are rod-shaped, and usually motile. They are chemo-organotrophic, and most species can grow only in the absence of air. There are many species, found in soil, in aquatic habitats, in animal intestines, etc. The genus includes some important pathogens, e.g. the causal agents of botulism, tetanus, and gas gangrene.

clothes moth *See* Tineidae.

clothing louse (*Pediculus humanus*) *See* Pediculidae.

cloud amount The proportion of the sky seen to be covered by cloud. Nowadays it is commonly measured in 'oktas' or eighths of the sky covered, but sometimes it is quoted as a percentage, or as tenths.

cloud base The undersurface of cloud, marked by obscurity due to water droplets or ice.

cloudburst Term popularly applied to exceptionally heavy precipitation, of shower or thunderstorm type.

cloud classification Clouds have been classified by various systems according to form, altitude, and the physical processes generating them. The World Meteorological Organization (*International Cloud Atlas*, 1956) classifies 10 genera in three major groups (cumulus or heap clouds, stratus or sheet clouds, and cirrus or fibrous clouds) by criteria essentially based on cloud form. The genera are subdivided according to variations in internal shape and structure, to give 14 species. Additional or supplementary features—e.g. transparency, arrangement, and characteristics of growth—are defined by Latin names as variants and accessory

types of cloud. The principal cloud genera, with their abbreviations, are: cirrus (Ci), cirrocumulus (Cc), cirrostratus (Cs), altocumulus (Ac), altostratus (As), nimbostratus (Ns), stratocumulus (Sc), stratus (St), cumulus (Cu), cumulonimbus (Cb). Clouds can also be referred to, according to their composition, as water or ice clouds; combinations of these are called mixed cloud.

cloud discharge Electrical discharge in a thunder cloud. *See also* lightning.

cloud droplet The liquid component of clouds, occurring as water droplets with an average size of 10 μm. In a non-rain cloud the droplets are suspended at a near-constant level, because air friction approximately balances the gravitational force.

clouded leopard (*Neofelis nebulosa*) *See* Felidae.

cloud forest Tropical montane forests located between 1000 and 2500 m (or even higher) above sea-level, and shrouded in cloud for much if not all of the year. The moisture encourages profuse epiphytic growth, especially of ferns, filmy ferns, lycopods, and mosses.

cloud seeding Process of introducing nuclei, e.g. silver-iodide crystals or solid carbon dioxide (dry ice), into clouds composed of supercooled water droplets, in an attempt to induce precipitation. Dry ice introduced (at −80 °C) from the air into cloud lowers the air temperature so that (particularly at temperatures below −40 °C) some of the supercooled water droplets are converted into ice crystals which then grow by collisions with further droplets. Silver iodide (which has a crystal structure similar to that of ice), introduced from the air or ground, is the substance most commonly used in seeding: its crystals act as ice nuclei. Other substances, e.g. common salt or fine water droplets, may also be used to encourage coalescence. Natural seeding may be significant in cases where ice crystals from a high 'releaser' cloud (e.g. altostratus or cirrostratus) fall into a supercooled water 'spender' cloud (e.g. nimbostratus) and encourage ice-crystal growth.

cloud street Band (or bands) of (usually) cumulus cloud parallel to the wind direction in a sky otherwise more or less clear of cloud. Streets may form in an air mass of a sharply demarcated convection layer, with separate thermals producing parallel streets.

clove Spice consisting of the young flower bud of *Eugenia caryophyllus*, native to the Moluccas, and now produced mainly in Zanzibar.

clovers *See Trifolium*.

clown loach (*Botia macracantha*) *See* Clinidae.

clown triggerfish (*Balistoides conspicillum*) *See* Balistidae.

clubmosses See Lycopsida.

clubroot (finger and toe) Serious disease of cruciferous plants, e.g. cabbages and broccoli. Symptoms include wilting of plants in bright sunshine, and the leaves may take on a bluish or reddish coloration. The roots show characteristic gall-like swellings. The disease is caused by *Plasmodiophora brassicae*. This organism can survive in the soil for many years, even in the absence of host plants.

club rush *See Scirpus*.

Clupea harengula (herring) *See* Clupeidae.

Clupeidae (herring, shad; class Osteichthyes, subclass Actinopterygii, order Clupeiformes) Large family of mainly marine fish which have compressed, streamlined bodies with a single soft-rayed dorsal fin half - way down the back, and a forked tail fin. Nearly all clupeids have a serrated belly, the protruding scales giving the ventral side a rough appearance. The family includes many commercially important species, for example, *Clupea harengula* (herring), *Sardina pilchardus* (pilchard), and *Brevoortia tyrannus* (Atlantic menhaden). Some species, for example *Dorosoma cepedianum* (American gizzard shad), are found only in freshwater systems. Like many other clupeids, they move in large schools, feeding on plankton. They are found worldwide, in temperate and tropical waters.

Clupeiformes (class Osteichthyes, subclass Actinopterygii) Order of herring-like, marine or freshwater fish, characterized by a streamlined, silvery body, and soft-rayed fins. The ventral fins are in an abdominal position opposite the single dorsal fin; the pectoral fins are inserted below the body axis. The order comprises the families Denticipitidae (denticle herring), Clupeidae (herring), Engraulidae (anchovy), and Chirocentridae (wolfherring).

Clupeomorpha Superorder of bony fish including the order Clupeiformes.

Clusia (family Guttiferae) Genus of woody trees or shrubs, most of which are stranglers. There are 14 species, occurring in tropical and subtropical forests, mainly in the New World, but also in Madagascar and New Caledonia.

cluster cup Common name for the cup-shaped aecium formed, for example, on the leaves of plants infected by certain rust fungi (order Uredinales).

Clypeasterina (order Clypeasteroida) Suborder of sand-dollars with discontinuous interambulacra terminated by a pair of plates at the apical system. They first appeared in the Upper Eocene.

Clypeasteroida (sand-dollars; class Echinoidea) Order of irregular echinoids with ambulacra that are wider than the interambulacra on the lower surface. Accessory tube - feet are developed outside the ambulacral petals. They first appeared in the Palaeocene (Tertiary).

clypeus Cuticular area of the head of an invertebrate animal, which lies between the frons (the front part of the head capsule) and the labrum, with which there is an articulation.

Cneoraceae (spurge olives) Family of small shrubs which bear flowers in axillary cymes, the peduncle fused below to the petiole. The flowers are tri- or tetramerous, their parts free on an elongated receptacle. The ovary is three- or four-celled,

forming 1–4 small drupes in the fruit. There is one genus (*Cneorum*) of few species, occurring in the Mediterranean region.

Cnidaria Phylum comprising the sea anemones, jellyfish, and corals, which is known from the late Precambrian. The Ediacaran fauna from S. Australia, from between 680 and 580 million years ago, includes clearly identifiable jellyfish and their allies. Corals occur for the first time in Ordovician rocks.

Cnidospora (phylum Protozoa) Subphylum of protozoa which form complex spores containing threads called polar filaments. These filaments can be extruded, and function in attachment. There are two classes. They are parasites in a range of vertebrate and invertebrate hosts.

co-adaptation Development and maintenance of advantageous genetic traits, so that mutual relationships can persist. Predator–prey and flower–pollinator relationships often exhibit examples of co-adaptation, which is an aspect of co-evolution.

coal Carbon-rich deposit formed from the remains of fossil plants. These are deposited initially as peats, but burial and the increase in temperatures at depth bring about physical and chemical changes. The process of 'coalification' results in the production of coals of different ranks, from peat, through the bituminous coals and anthracite, to lignite. Each rank marks a reduction in the percentage of volatiles and moisture, and an increase in the percentage of carbon. These are termed 'woody' or 'humic' coals since they are formed from fragments of trees or bushes. If the major constituents of coal are pollen grains and/or finely-divided plant debris, the term 'sapropelic coal' is used.

coalescence Process of cloud water droplet enlargement, as larger drops (more than 19 μm) fall and collide with smaller drops. Ice crystals in frozen cloud tops may also fall and grow by coalescence with drops below, ultimately melting into raindrops. In cumuliform cloud, turbulence may encourage this process of drop growth by the upthrust of small droplets to overtake and coalesce with other droplets. Repetition of the process can eventually produce rain-sized droplets. Factors favouring coalescent growth are high moisture content, water cloud of large vertical extent, and strong upward turbulence. *See also* Bergeron–Findeisen theory; and collision theory.

coarctate Applied to a pupa in which the puparium is composed of the cuticle of the final larval instar.

coast redwood (*Sequoia sempervirens*) *See Sequoia*.

coati *See* Procyonidae.

coats-of-mail-shells *See* Polyplacophora.

cobalamine A form of vitamin B_{12}.

cobalt glance *See* cobaltite.

cobaltite (cobalt glance) Mineral, specific gravity 6.0–6.5, hardness 5.0–6.0, chemical composition CoAsS. It occurs mainly in hydrothermal veins and contact metamorphic zones, associated with chalcopyrite, sphalerite, chlorite, tourmaline, and apatite. It is distinguished by its reddish tinge, great hardness, and crystal form. It ranges from white to dark grey or greyish-black, all with a reddish tinge. Its streak is grey-black, and it has a metallic lustre. It crystallizes in the cubic system. The crystals are octahedra, cubes, and pentagonal-dodecahedra, also massive, and in irregular grains. It is one of the principal ore minerals for cobalt.

cobia *See* Rachycentridae.

Cobitidae (loaches; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of mainly small, slender-bodied, freshwater fish, with tiny scales, and toothless jaws. The ventrally-positioned mouth bears at least three pairs of barbels. Cobitidae occur in swift-flowing mountain streams as well as in slow-moving rivers. When the oxygen concentration of the surrounding water falls to a low level, loaches can gulp in air and extract oxygen via well-vascularized parts of the gut. Many species are sensitive to changes in atmospheric conditions. *Misgurnus fossilis* (European weatherfish), growing to at least 20 cm, has been used in the past as a barometer because it becomes more active when a weather depression approaches. Other species, e.g. *Acanthophthalmus kuhlii* (kuhli loach) and *Botia macracantha* (clown loach), are popular aquarium fish. There are nearly 150 species, found mainly in Europe and Asia.

cobnut *See Corylus*.

cobra (king) *See Ophiophagus hannah*.

cobras *See* Elapidae.

cobweb spiders *See* Theridiidae.

cocaine Drug obtained from *Erythroxylum coca*. *See also Erythroxylum*.

Coccidae (scale insects, mealybugs; order Hemiptera, suborder Homoptera) Family of homopterans which feed on plant sap, and some species of which are pests. Females are wingless. Males have a single pair of wings and do not feed; usually they are very small. The newly-hatched nymphs (crawlers) are the main dispersal stage, and are blown about by the wind. Most older nymphs and females are sedentary, except in the mealybugs and their relatives, in which some mobility is retained. There are about 4000 species occurring mainly in the tropics. The Coccidae belong belong to a group that is usually split into about 12 families (*see also* Lacciferidae).

Coccidia (class Telosporea) Subclass of parasitic protozoa which grow and reproduce inside the cells of an animal host. There are two orders, and many species.

coccidioidomycosis Disease of humans and other animals caused by the fungus *Coccidioides immitis*. There are two forms of the disease: a mild respiratory condition resembling influenza, and a disseminative, progressive disease which may be fatal.

coccidiosis Any disease caused by a protozoon of the suborder Eimeriina (e.g. *Eimeria*, *Isospora*). These organisms do not often cause disease in humans, but they may cause important economic

losses among domestic animals. The disease usually affects the intestine, and symptoms often include diarrhoea with bloody stools.

Coccinella septempunctata (seven-spot ladybird) *See* Coccinellidae.

Coccinellidae (ladybirds, ladybugs, lady-beetles; class Insecta, order Coleoptera) Family of rounded, convex, usually shiny beetles, coloured red, black, or yellow, with a pattern of spots, or lines. The head is largely covered by the pronotum. The antennae are short, and clubbed. Larvae are very active, with well-developed legs. They are often grey with a pattern of spots. Some are covered with spines, or a white, waxy coat. If provoked, adults and larvae exhibit reflex bleeding, producing a sticky orange fluid from 'knees' or spines: presumably this has a deterrent effect. Economically they are very important, and are used in biological control. The majority, e.g. *Coccinella septempunctata* (seven-spot ladybird), feed on aphids and plant pests. Some are fungus feeders. Others, e.g. *Epilachna varivestis* (Mexican bean beetle) are phytophagous and attack crop plants. There are 5000 species.

coccolith Microscopic calcareous plates or discs, generally oval and perforated, that occur as part of the protective covering of a group of the unicellular algal family Coccolithophoridae. They are a major component of the modern deep-sea calcareous oozes, and were especially abundant in the Mesozoic, particularly the Cretaceous Period, in which they became a major component of the Chalk lithology.

Coccolithophoridae (class Prymnesiophyceae) Unicellular, marine, planktonic protists which are covered in calcareous plates (coccoliths) embedded in a gelatinous sheath. They are spherical or oval, and less than 20 μm in diameter. They range in age from the Upper Triassic to Recent, although dubious examples have been described from the Upper Precambrian and Palaeozoic.

Coccothraustes (hawfinches; family Fringillidae) Genus of large, stout finches with massive conical bills and well-developed jaw muscles that enable them to crack fruit stones. The inner primaries of *C. coccothraustes* are notched and curled. The genus is found mainly in forests, feeds on seeds, kernels, and berries, and nests in trees and bushes. There are nine species, found in Europe, N. Africa, Asia, N. America, and Mexico.

Coccothraustes coccothraustes *See Coccothraustes.*

coccus Bacterial cell that is spherical, or nearly so.

Coccyzus (cuckoos; family Cuculidae) Genus of small to medium-sized cuckoos with white-tipped tail feathers. They are secretive and are found in forest and open woodland, feed on insects, and nest in trees. There are eight species, found in N., C., and S. America.

cochineal Dye (cochinealin, or carminic acid, $C_{22}H_{20}O_{13}$) plus a wax and a fat, all three of which have commercial uses, obtained from the dried bodies of female *Dactylopius coccus* (family Coccidae), hemipteran insects which feed on cacti and are native to Mexico and Peru. The insects are cultivated in parts of C. America, S. Europe, and N. Africa.

cochlea Part of the inner ear of some reptiles, birds, and mammals. It is concerned with the analysis of the pitch of received sound. In mammals other than Monotremata it is spirally coiled.

Cochleariidae (boat-billed heron; order Ciconiiformes) Family of one monotypic genus, *Cochlearius cochlearius*, sometimes placed with Ardeidae. It is a medium-sized heron with a grey back and a black, long-feathered crown. Its bill is very broad, flat, and slightly hooked; and its middle toe is pectinate. It inhabits marshes, feeds on fish, crabs, and amphibians, and nests in trees. It is found in C. and S. America. *See also* Ardeidae.

Cochlearius cochlearius (boat-billed heron) *See* Ardeidae; and Cochleariidae.

Cochlospermum (family Cochlospermaceae) Genus of trees in which the leaves are palmately divided, and the flowers showy and pentamerous. The fruit is a capsule with many hairy seeds. There are 15–20 species, occurring in the tropics and subtropics.

cockatoos *See* Psittacidae; and Psittaciformes.

cockchafer (*Melolontha melolontha*) *See* Scarabaeidae.

cock-of-the-rock (*Rupicola*) *See* Cotingidae.

cockroaches **1** *See* Blaberidae; Blattellidae; Blattidae; Blattodea; Cryptocercidae; Dictyoptera; *Ectobius*; and Polyphagidae. **2** (American cockroach) *See Periplaneta americana.* **3** (German cockroach) *See Blattella germanica.* **4** (oriental cockroach) *See Blatta orientalis.*

cockroach wasp *See* Ampulicidae.

cockscomb (*Celosia cristata*) *See* Amaranthaceae.

cocksfoot grasses *See Dactylis.*

cocoa *See Theobrama.*

coconut (*Cocos nucifera*) *See Cocos.*

cocoon Silken sheath which the pupae of many insects, e.g. moths and bees, spin around themselves for protection during this vulnerable stage in their life cycle. In the case of the silk moth, this covering can be unwound and spun into thread for the making of silk cloth.

coco plum *Chrysobalanus icaco. See* Chrysobalanaceae

Cocos (family Palmae) Genus of one species, *C. nucifera*, the coconut ('nature's greatest gift to man') which grows wild on sandy coasts from the east coast of Africa to Polynesia, and also in the Caribbean. It is very widely cultivated from 20° N to 20° S. It has a solitary stem, and leaves with many leaflets. The fruit is a nut with a fibrous mesocarp (the source of coir fibre), and stony endocarp (the source of a fine medicinal charcoal), lined by endosperm (the source of copra).

cocoyam (*Colocasia esculenta*) *See Colocasia.*

COD *See* chemical oxygen demand.

cod (*Gadus morrhus*) *See* demersal fish; and Gadidae.

Codiaeum (family Euphorbiaceae) Genus of small trees and shrubs which includes *C. variegatum* (garden croton), a widely-grown shrub with numerous varieties having differently coloured leaves. There are 15 species, occurring in the Indo-Malaysian tropics.

Codiales (Siphonales; class Chlorophyceae) Order of siphonaceous green algae in which the thallus is typically large, and in which there are no cross-walls separating the many nuclei and chloroplasts. The organisms are seaweeds found mostly in warmer regions.

cod icefish *See* Nothothenidae.

codlets *See* Bregmacerotidae.

codominant Heterozygote that shows fully the phenotypic effects of both alleles at a gene locus. For example, humans of the AB blood group show the phenotypic effect of both I^A and I^B codominant genes.

codon Triplet sequence of nucleotides in messenger-RNA that acts as a coding unit for an amino acid during protein synthesis. It binds by base-pairing to a complementary sequence, the anti-codon, in transfer-RNA.

Codonocarpus (family Gyrostemonaceae) Genus of trees, previously included in the family Phytoloccaceae, and including *C. cotonifolius* (native poplar). The genus comprises two species, both endemic to the arid interior of Australia.

Codonocarpus cotonifolius (native poplar) *See Codonocarpus.*

coefficient of coincidence Experimental value of the observed number of double recombinants (cross-overs) divided by the expected number.

coefficient of inbreeding Probability that two allelic genes forming a zygote are both descended from a gene found in an ancestor common to both parents. It is also used for the proportion of loci at which an individual is homozygous. The coefficient of consanguinity of an individual is the probability that two homologous genes drawn at random, one from each of the two parents, will be identical, and therefore homozygous in an offspring. The term is sometimes known as Wright's inbreeding coefficient (F), after the geneticist Sewall Wright who formulated it. $F = 1/2$ for a selfed mating; 1/4 for full-sib mating; 1/8 for uncle × niece and aunt × nephew, or double first cousins (i.e. cousins by both parents); and 1/16 for first cousins.

Coelacanthiformes (class Osteichthyes, subclass Crossopterygii) Order of bony fish thought to have been extinct for 50 million years (since the end of the Mesozoic Era) until the discovery of the coelacanth *Latimeria chalumnae* off S. Africa in 1938. Both fossil and living coelacanths are bulky marine fish with a diphycercal or tri-lobed tail-fin, the second dorsal, anal, pectoral, and pelvic fins being very unusual as they are supported by movable stalks or lobes. The much smaller fossil species lived from the Devonian to the Cretaceous. They were initially freshwater fish, but in the Triassic marine representatives also evolved.

Coelacanthimorpha Superorder of bony fish including the order Coelacanthiformes. *See* Actinistia.

Coelenterata Name formerly applied to a phylum comprising both Cnidaria and Ctenophora. Today, when these two groups are universally separated in different phyla, the term 'Coelenterata' is sometimes used as a synonym for Cnidaria alone.

coelenteron *See* mesentery.

Coelodonta (woolly rhinoceros) *See* Rhinocerotidae.

coelom Principal body cavity in animals, forming the cavity around the gut in many Annelida, and in Echinodermata and Vertebrata. In Arthropoda and Mollusca, the main body cavity is an expanded part of the blood system (a haemocoel) and the coelom is small.

coelomoduct In invertebrates, a duct formed from the lining (mesoderm) of the coelom, and connecting the coelom with the exterior. In some animals this is used to convey products of the gonads; in others to convey metabolic wastes.

Coelomycetes (subdivision Deuteromycotina) A class of imperfect fungi which produce conidia within acervuli or pycnidia. The vegetative state is a mycelium. They are saprotrophic on plant debris, soil, etc; some can also cause disease in plants. Some have perfect states classified in the Ascomycotina.

Coelophysis One of the first flesh-eating dinosaurs, recorded from the Late Jurassic of N. America. It was a slender, bipedal coelurosaur less than 2 m in length, weighing approximately 23 kg. It had a small skull with sharp serrated teeth, a long neck and tail, and hands with long, grasping fingers.

Coelopidae (kelp flies, seaweed flies; class Insecta, order Diptera, suborder Cyclorrapha) Small family of true flies which are often hairy or bristly, and somewhat flattened. The antennae are often held in scrobal hollows, and the postvertical bristles are convergent. The legs may be bristly, or woolly with preapical bristles. The wing has the costa unbroken and Sc complete, with vein 1A extending to the margin (*see* venation). These flies are usually associated with the seashore, as their larvae feed on rotting seaweed on the strand-line. Some species make short mass migrations, and may also be attracted to aromatic chemicals. Only 48 species have been described.

Coelostegia (family Bombacaceae) Genus of trees in which the young parts have silvery scales. The fruit is a big, spiny capsule; the seeds are arillate. There are five species, occurring in the rain forests of Malaya and Borneo.

Coelurosauria (Order Saurischia, suborder Theropoda) Family of carnivorous, bipedal dinosaurs, which were the most persistent of the infra-ordinal dinosaur groups, extending from Triassic to Cretaceous times. The largest measured about 3 m long, although the great majority of these rather slender, agile dinosaurs were much smaller.

Coenagriidae *See* Coenagrionidae.

Coenagrionidae (Coenagriidae, damselflies; order Odonata, suborder Zygoptera) Cosmopolitan family of damselflies, most of which are small and brightly coloured: they can be seen skimming over the surface of still water. The fourth and fifth branches of the radius fork from the radial sector nearer to the nodus than the arculus in the wing. The nymphs live among aquatic vegetation in still water, and have slender caudal gills. More than 1290 extant species have been described.

Coendou (tree porcupine) *See* Erethizontidae.

coenenchyma Substance that links colonial polyps, sometimes fleshy but often calcified.

coenobium Algal colony consisting of a definite number of cells in a specific arrangement. The colony as a whole behaves as an individual organism.

coenocline Gradient of communities (e.g. in a transect from the summit to the base of a hill), reflecting the changing importance, frequency, or other appropriate measure of different species populations. The term is applied most widely to vegetation records. *See also* ecocline; *compare* complex-gradient.

coenocyte Cell or organism with many nuclei which are not separated by cell walls. This condition is caused by the repeated division of the nucleus, but not of the cytoplasm, of the original cell.

coenoecium *See* Rhabdopleurida.

coenosarc Within the stems of colonial coelenterates, material that links the individuals.

Coenothecalia (subclass Octocorallia) Order of colonial corals which appeared first in the Cretaceous and which includes the modern genus *Heliopora* (blue coral) common in tropical Pacific reefs. Members are characterized by a massive skeleton of fibrocrystalline aragonite, the skeleton being perforated by wide tubes which house the polyps, and by narrow tubes containing blind downgrowths of solenial tissue. The order contains two families, and three genera.

coenzyme Organic substance that acts as a cofactor for an enzyme.

coevolution Complementary evolution of closely associated species. The interlocking adaptations of many flowering plants and their pollinating insects provide some striking examples of coevolution. In a broader sense, predator–prey relationships also involve coevolution, with an evolutionary advance in the predator, for instance, triggering an evolutionary response in the prey.

cofactor Non-protein component required for its function by an enzyme, and to which it may be either tightly or loosely bound. Cofactors that are tightly bound are known as prosthetic groups. Cofactors are required by many enzymes: they may be metal ions (activators) or organic molecules (coenzymes), and generally act as donors to or acceptors from the substrate (or substrates) of functional groups of atoms. Examples are NAD, NADP, and ATP, which are used after electrophoresis, for example, in histochemical staining for the specific enzymes.

Coffea (family Rubiaceae) Genus of shrubs and small trees which occur in the Old World tropics, especially Africa. The fruit is a berry. *C. arabica* gives Arabian coffee, of the highest quality; *C. liberica*, grown mainly at lower elevations, gives Liberian coffee; and *C. canephora* gives robusta coffee. Beans of the latter two are blended with beans from *C. arabica*.

coffee *See Coffea*.

cohort 1 Group of individuals of the same age. 2 In plant taxonomy, a group of related families; in animal taxonomy, a group of orders.

cohune palm (*Orbignya cohune*) *See Orbignya*.

Coilostega (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans in which the lateral dorsoventral muscles (moving the frontal membrane) pass through special notches or holes in the zooid. The division occurs from the Middle Jurassic to Recent.

coir Fibre produced from *Cocos nucifera*. *See Cocos*.

Coix (family Gramineae) Genus of five grass species which occur in tropical Asia. *C. lachryma* is Job's tears, a cultivated cereal of subtropical Asia.

col 1 High pass or saddle in a ridge. It may mark the line of a former stream valley, or of a former glacier, and so provide evidence of an early stage in the development of the landscape. 2 (meteorol.) The saddle region of the pressure field between two high- and two low-pressure centres.

Cola (family Sterculiaceae) Genus of small trees, several species of which provide kola nuts, which contain much caffeine, and are widely traded in W. Africa as a stimulant to combat fatigue. There are 125 species, occurring in Africa.

colchicine Alkaloid drug obtained from meadow saffron. It has a disruptive effect on microtubular activity, though not that of microfilaments. Thus it affects tissue metabolism generally and mitosis in particular.

cold-blooded *See* poikilotherm.

cold, common *See* common cold.

cold front Boundary between dense, cold air and the warmer air ahead of it, which the cold air tends to undercut as it advances. The gradient of the upper surface of the cold air may be steep, e.g. 1 : 50. Along this steep front violent upwelling and instability result in high cumulonimbus cloud with rain and thunder. Weather changes occur with the passage of a cold front, including sometimes pronounced temperature fall, rise in pressure, and wind veering (often with squalls) to northerly or north-westerly (in the northern hemisphere). The passage commonly brings clearer, brighter weather, but the unstable air can produce showers.

cold-front clearance Clearing of the sky after the passage of a cold front, the cold air displacing the warm, moist air of the warm sector as a depression

moves away. The process is usually marked by a veering of the wind (in the northern hemisphere, backing in the southern hemisphere), rising pressure, and a fall in temperature. The clearing of the cloud may be partly due to some subsiding motion in the upper layers behind the front.

cold glacier (polar glacier) Glacier whose temperature is below the pressure-melting point. It is frozen to its bed, so basal sliding does not occur; and the rate of internal deformation is slight as a result of the low temperature. Little erosion or deposition therefore occurs.

cold low Basically non-frontal depression, typically associated with circulation in cold air masses in the mid-troposphere over NE USA and NE Siberia, though sometimes occurring also over the oceans in air that has emerged from the Arctic. They are marked by more or less concentric isotherms around the core of the low. Such lows may originate along the Arctic coast as a result of strong vertical uplift and adiabatic cooling in occlusions; they do not necessarily influence surface weather conditions, but when they occur over warmer surfaces in middle latitudes, convection develops strongly. *See also* cut-off low.

cold pole The area or point in each hemisphere that has the lowest mean temperatures. Verkhoyansk, in NE Siberia is in the region of the northern hemisphere cold pole, with a January mean of −50 °C and an absolute minimum of −68 °C. Parts of Antarctica have recorded absolute temperatures of around −90 °C.

cold sector Zone of colder air surrounding the narrowing wedge of warm air, the warm sector, in a developing depression. At the occlusion stage the whole of the surface layer forms a cold sector, with the warm air lifted off the surface.

cold sore In mammals, an infectious, localized disease involving the formation of vesicles e.g. on lips or conjunctivae. The causal agent is the herpes simplex virus.

cold wave The conditions associated with air of continental polar origin, often dominated by an anticyclone behind a cold front, that moves south into central and eastern parts of the USA. Cold waves are defined as a fall of 11 °C or more to a minimum base (−18 °C in northern, central, and north-eastern regions) within a 24-hour period. In southern states (Florida, California, and the Gulf Coast) the minimum fall is 9 °C and the base minimum 0 °C.

Coleoidea (phylum Mollusca, class Cephalopoda) Subclass of cephalopods which have a dibranchiate gill arrangement. The true shell, if it occurs at all, is internal. The head possesses eyes and a mouth that bears a pair of mandibles and a radula. Eight arms extend from the head. Some forms also have two additional, retractile tentacles. A tube-like hyponome is also present. There are four extant orders and one extinct order. The subclass first appeared in the Lower Carboniferous.

Coleophoridae (order Lepidoptera) Widespread family of very small to small moths. The wings are fringed with long, hair-like scales. At rest the antennae are held porrect. Larvae are leaf-miners in the first instar, and then construct cases. As case-bearers, the larvae feed externally or are leaf-miners. Pupation usually occurs in the larval case.

Coleoptera (beetles; class Insecta, subclass Pterygota, division Endopterygota) An order of endopterygote insects, which have biting mouthparts, and in which the forewings are modified into more or less horny, rigid elytra (wing cases) which meet medially when at rest and partly or wholly cover the hindwings and abdomen. When present, the hindwings are membranous and much folded when at rest. They are the sole means of flight, although the elytra are said to provide some lift in some groups. The head and well developed prothorax form a distinct forebody, while the hind body comprises the meso- and metathorax and abdomen, covered by the elytra. The mesothorax is usually reduced, and the abdominal sterna are more strongly sclerotized than the tergites. The larvae have a distinct head capsule, with antennae and well developed mandibles, and may or may not have thoracic legs. The pupae are adecticous (have non-articulated mandibles, which are often reduced). They are also said to be exarate (with their appendages free and not stuck down to the body by secondary attachments). The Coleoptera is the largest order of animals, with at least 350 000 species.

Coleosporiaceae (order Uredinales) Family of fungi which is sometimes recognized to include those rust fungi in which the teliospores are sessile and occur in a distinct layer. However, all rusts with sessile teliospores are more usually included in the family Melampsoraceae.

colies *See* Coliidae.

coliform Applied to *Escherichia coli* and similar bacteria that are normally resident in the intestines of humans and other animals.

Coliidae (mousebirds, colies; order Coliiformes) Family of brown or grey, short-winged and very long-tailed birds. They are crested, with bare skin around the eye; short, stout, curved bills; and short, strong feet, the hind toe being reversible so that all four toes point forward. They are found in scrub and bushes, feed on fruit and vegetable matter, and nest in trees and bushes. There is one genus, *Colius*, containing six species, all of which are confined to Africa.

Coliiformes (mousebirds, colies; class Aves) Order of a single family, Coliidae.

colinearity The correspondence between the order of nucleotides in a section of DNA (cistron) and the order of amino acids in the polypeptide that the cistron specifies. The evidence for this is that the positions of mutation within a particular cistron correspond to, and are in the same order as, the positions at which amino-acid substitutions are found in the polypeptide coded by the cistron.

Colisa labiosa (thicklip gourami) *See* Belontiidae.

Colius *See* Coliidae.

collagen Fibrous schleroprotein of high tensile strength which is a major constituent of connective tissue and the organic material in bone. It may represent up to 6% of the total body weight. It is unusual among proteins in that glycine, proline, and hydroxyproline represent over 50% of the total amino-acid residues; and these are arranged in a tight, triple left-handed helix. When boiled, collagen yields gelatin.

collared dove (*Streptopelia decaocto*) *See Streptopelia*.

Collemataceae (order Lecanorales) Family of lichens in which the thallus is gelatinous, and typically black when wet. The phycobiont is a cyanobacterium of the genus *Nostoc*. The thallus ranges in type from nearly crustose to foliose, or almost fruticose. There are several genera, found on various types of substrate in moist habitats.

Collembola (springtails) Class and order of primitive, eyeless, wingless, small hexapods, exhibiting simple metamorphosis, which have entognathous (eversible and contained within a small pocket), biting mouthparts, short antennae, six-segmented abdomens (sometimes fused), and legs which lack tarsi. Most species are less than 6 mm long, and can leap by means of a special, forked, springing organ (the furca or furcula) which is held up against the underside of the abdomen by a catch (retinaculum, hamula, ventral tube, or collophore): when the furca is moved downwards suddenly, it hits the substrate and propels the animal through the air. There are two suborders, the elongate Arthropleona, and the globular Symphypleona whose members have the mouthparts tucked under the head. They live in soil, leaf litter, under bark and decaying wood, and among fungi and vegetation, and are very common, attaining densities of 60 000/m^2. Some species are pests of leguminous crops, but most are important as scavengers and agents of nutrient recycling. Some species live on the water surface of ponds, or even on alpine snowfields where they feed on pollen and other debris. There are about 2000 species worldwide.

collet Underwood that is cut according to a rotation, mainly for conversion to charcoal.

Colletes *See* Colletidae.

Colletidae (order Hymenoptera, suborder Apocrita) Cosmopolitan family of primitive bees, which is best represented in the Australian region. The tongue is short, broad, and emarginate apically, modified as a kind of paintbrush and used to apply the waterproof cell lining of macrocyclic lactones, which are secreted by the Dufour's gland in the abdomen. Females of the subfamilies Hylaeinae (comprising the genera *Hylaeus*, *Meroglossa*, and *Palaeorhiza*) and Eurglossinae have no pollen scopa, and transport pollen in the crop. The principal ground-nesting genus, *Colletes*, is absent from Australia but is otherwise cosmopolitan. Most hylaeines nest in pithy stems or insect borings in wood.

Colletotrichum (family Melanconiaceae) A form-genus of fungi which includes a number of important plant pathogens. *Colletotrichum* species can cause disease, e.g. in legumes, cotton, grasses (including cereals), and flax.

collision theory Theory to account for the growth of water droplets in cloud to produce raindrops, based on the mechanisms of collision, coalescence, and 'sweeping'. It holds that larger drops, with terminal velocities increasing in proportion to their diameter, fall faster than smaller drops, and collide with them. The probability of collision depends on the spacing of the drops in the cloud (i.e. on the mean free path) and on the relative sizes of droplets —e.g. if some drops are up to 50 μm diameter in cloud consisting mainly of droplets smaller than this, collisions can be frequent. Such collisions can lead to coalescence, and an overall increase in size to produce particles of raindrop size. 'Sweeping' is an ancillary process whereby small drops that are swept into the rear of larger drops may be absorbed. These mechanisms are believed to be entirely responsible for rainfall from tropical convection cloud, as well as playing a part in other clouds, including those of mid-latitudes. *See also* Bergeron theory.

colloblast In Ctenophora, an adhesive cell on the tentacle used to capture food.

Collocalia (swiftlets; family Apodidae) Genus of small swifts with narrow wings and a notched tail. They are aerial, sometimes found in trees, and feed on insects. They nest in caves, building nests of saliva and vegetable matter, many of which are regarded as edible. They use echo-location to fly in darkness. There are 21 species, found in SE Asia, Australia, the Pacific and Indian Ocean islands, the Seychelles, and the Mascarenes.

colloid 1 Substance composed of two homogeneous phases, one of which is dispersed in the other. 2 (pedol.) Soil colloids are substances of very small particle size, either mineral (such as clay) or organic (such as humus), which therefore have a large surface area per unit volume. Colloids usually provide surfaces with high cation-exchange capacity, and also exhibit an instability controlled by soil chemistry.

collophore *See* Collembola.

colluvium Weathered rock debris that has moved down a hillslope either by creep or by surface wash.

Collybia (family Tricholomataceae) Genus of fungi in which the fruit body is mushroom-shaped with a convex cap, and (when young) an inrolled margin. The spore print is white. There are many species, some of which are edible, found on the ground, on rotting wood, etc.

Colobus (guereza, colobus monkeys) *See* Cercopithecidae.

Colocasia (family Araceae) Genus of giant, rhizomatous herbs, which includes *C. esculenta* (taro, dasheen, or cocoyam). These herbs are cultivated extensively, especially in Melanesia and Polynesia, as a staple carbohydrate. There are eight species, occurring from India to Polynesia.

Cololabis saira (Pacific saury) *See* Scomberesocidae.

colon In vertebrates, the large intestine, concerned in many animals with the absorption of water from the contents of the intestine, but in some Mammalia concerned with the digestion of cellulose.

Colorado beetle (*Leptinotarsa decemlineata*) *See* Chrysomelidae.

Colorado low Storm resulting from cyclone regeneration over E. Colorado, USA.

colostrum Milk secreted in the first few days after parturition: it differs in its physical and biological properties from that secreted later. It contains a large number of globulins that represent all the antibodies in the maternal blood and therefore confers temporary passive immunity upon the newborn mammal.

Coluber viridiflavus (dark-green whip snake, European whip snake, western whip snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snake which is harmless, though aggressive and agile. It grows to a maximum length of 1.9 m, and is uniformly black, or dark-greenish (or black) with yellow bars and streaks. It occurs mainly in France, S. Switzerland, and Italy.

Colubridae (colubrid snakes; order Squamata, suborder Serpentes (Ophidia)) Family of snakes, most of which are harmless, with solid teeth; but some of which are poisonous, with teeth at the back of the jaws grooved for venom. The left lung is small, or absent. They have no trace of hind limbs. There are about 1000 species, distributed throughout the world. *See also Coluber viridiflavus*; *Coronella austriaca*; *Dispholidus typus*; egg-eating snakes; *Elaphe*; and *Natrix*.

colugo (*Cynocephalus*) *See* Cynocephalidae.

colulus *See* spinnerets.

Columba (pigeons; family Columbidae) Genus of typical pigeons, mainly medium-sized, brown, grey, or black birds. They inhabit forests, woodland, and open country; feed on seeds and fruit; and nest in trees, crevices, and on ledges. *C. livia* (rock dove) is the wild ancestor of the domestic pigeon. There are 51 species, found worldwide.

Columba livia (rock dove) *See Columba*.

Columbidae (pigeons, doves; order Columbiformes) Family of small to large birds with soft, dense plumage, plump bodies, and small heads. The bill is short to medium with a bare cere, and the legs are generally short. Most are arboreal, though some are terrestrial, and feed mainly on seeds and fruit, regurgitating a milky fluid for their young. They usually nest in a tree or on a ledge. They are gregarious, and many are migratory. They are popular cage birds. There are 40 genera, with 296 species, found worldwide. *Ectopistes migratorius* (passenger pigeon) is one of many extinct species.

Columbiformes (pigeons, doves, sandgrouse; class Aves) Order of two families, Columbidae and Pteroclididae. A third family, Rhaphidae, is now extinct.

Columbina (ground doves; family Columbidae) Genus of small, plump, greyish or reddish-brown, short-tailed doves. They are found in grassland and open country, feeding mainly on the ground on seeds, and nesting in trees, bushes, and on the ground. There are seven species, found in N., C., and S. America.

columbines *See Aquilegia*.

columbite (niobite) Mineral, specific gravity 5.6–5.8, hardness 6.0–6.5, chemical composition $(Fe,Mn)(NbTa)_2O_6$, whose name is derived from columbium, the American name for niobium. It occurs in granites and pegmatites in association with high-temperature minerals, e.g. cassiterite, wolframite, tourmaline, quartz, and feldspar. It is distinguished by its weak magnetism, black or brownish-black colour, and crystal form. It has a very dark red streak, and a sub-metallic lustre. It crystallizes in the orthorhombic system. The crystals are normally tabular and short prismatic forms, and can also be blade-like. It is a major ore mineral of niobium.

columella (mycol.) Central column of sterile tissue within a spore-bearing structure.

columella auris In amphibians, reptiles, and birds, a bony or cartilaginous rod connecting the tympanic membrane with the inner ear and transmitting sound. It is homologous with the hyomandibular bone in fish.

columnar jointing *See* joint.

Comasteracea (feather-stars; subclass Articulata, order Comatulida) Superfamily of feather-stars in which the centrodorsal plate is disc-shaped and low. The dorsal side of this ossicle is flattened and smooth, bearing no cirri. The centrodorsal cavity is less than one-third of the centrodorsal diameter. The superfamily first appeared in the Eocene.

comber 1 (*Serranus cabrilla*) *See* Serranidae. 2 Deep-water wave that has a breaking crest blown forward by a strong wind. The term is also applied to a long-period spilling breaker.

comb-footed spiders *See* Theridiidae.

comb jellies *See* Ctenophora.

Combretaceae Family of trees, shrubs, and climbers, in which the flowers are pentamerous, with an inferior ovary surmounted by a disc. The fruits are often winged, and sometimes are fleshy and edible. *Lumnitzera* and *Laguncularia* grow in mangrove forests and are viviparous. There are several ornamentals (*Quisqualis*), and many useful timber trees (*Combretum*, *Lumnitzera*, and *Terminalia*). There are 20 genera, with about 470 species, occurring mainly in the tropics.

Combretum *See* Combretaceae.

Comephoridae (Baikal oilfish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of freshwater fish found only in Lake Baikal (USSR). They have a scale-less body, a snake-like head, and very long pectoral fins. Almost translucent, the body has a high fat content.

Comesperma (family Polygalaceae) A genus of shrubs and twining plants, up to 1 m high, with small leaves, and small, pink to blue flowers

bunched at the end of the stems. There are 24 species, endemic to Australia and mainly restricted to southern states including Tasmania.

comfort behaviour Behaviour (e.g. yawning, scratching, and grooming) that increases the physical comfort of an animal.

comfort zone Range of atmospheric temperature and humidity characteristics within which the human body feels and works comfortably and efficiently. The typical zone is delimited by a temperature range of 19–24 °C. Beyond the limits corrective adaptations are necessary to produce bodily comfort.

Commelinaceae Family of often rather succulent herbs of moist places, which have scented, and often creeping, stems. The flowers are trimerous. There are many ornamentals. *Tradescantia* is spiderplant or wandering jew, and *Rhoeo* also is cultivated. There are 38 genera, with 500 species, of mainly tropical distribution.

commensalism Interaction between species populations in which one species, the commensal, benefits from another, sometimes called the host, but this other is not affected. *Compare* mutualism; and parasitism.

common bellowsfish (*Macrorhamphus elevatus*) *See* Macrorhamphosidae.

common bullseye (*Liopempheris multiradiata*) *See* Pempheridae.

common chameleon *See Chamaeleo chamaeleon.*

common cold Acute, self-limiting infection of the upper respiratory tract, involving inflammation of the mucous membranes. Colds may be caused by any of several viruses, including coronaviruses and rhinoviruses.

common crane (*Grus grus*) *See Grus.*

common cuckoo (*Cuculus canorus*) *See Cuculus.*

common darter *See Sympetrum striolatum.*

common eel (*Anguilla anguilla*) *See* Anguillidae.

common frog (*Rana temporaria*) *See* Anura.

common gallinule (*Gallinula chloropus*) *See Gallinula.*

common grass spiders (*Agelena*) *See* Agelenidae.

common horntail *See Uroceras gigas.*

common house spider *See Tegenaria gigantea.*

common iguana *See Iguana iguana.*

common jollytail (*Galaxias maculatus*) *See* Galaxiidae.

common kingfisher (*Alcedo atthis*) *See* Alcedinidae.

common lizard *See Lacerta vivipara.*

common lobster *See Homarus gammarus.*

common morwong (*Cheilodactylus douglasii*) *See* Cheilodactylidae.

common mullet (*Mugil cephalus*) *See* Mugilidae.

common musk turtle *See Sternotherus odoratus.*

common myna (*Acridotheres tristis*) *See Acridotheres.*

common of estovers *See* estovers.

common of mast *See* pannage.

common of pasturage *See* pasturage.

common of turbary *See* turbary.

common olive (*Olea europaea*) *See Olea.*

common pheasant (*Phasianus colchicus*) *See Phasianus.*

common pony-fish (*Leiognathus equula*) *See* Leiognathidae.

common rhea (*Rhea americana*) *See Rhea*; and Rheidae.

Commons, the Concept that the major resources of the planet—land, air and water—are commodities to which all people have equal right of access and use, and that no one has a right to spoil.

common sawshark (*Pristiophorus cirratus*) *See* Pristiophoridae.

common sea lavender (*Limonium vulgare*) *See* polyhaline.

common silk moth *See Bombyx mori.*

common sturgeon (*Acipenser sturio*) *See* Acipenseridae.

common tegu *See Tupinambis teguixin.*

common toad (*Bufo bufo*) *See* Anura.

common vetch (*Vicia sativa*) *See Vicia.*

common viper *See Vipera berus.*

common woodlouse *See Porcellio scaber.*

common wryneck (*Jynx torquilla*) *See Jynx.*

community (ecol.) General term applied to any grouping of populations of different organisms found living together in a particular environment; essentially, the biotic component of an ecosystem. The organisms interact (by competition, predation, mutualism, etc.) and give the community a structure. Globally, the climax communities characteristic of particular regional climates are called biomes. *See also* individualistic hypothesis.

community ecology An approach to ecological study which emphasizes the living components of an ecosystem (the community). Typically it involves description and analysis of patterns within the community, employing methods of classification and ordination, and examines the interactions of community members, e.g. in the partitioning of resources and in succession.

compaction Physical process that reflects the increase in pressures brought upon sediments as a result of deeper and deeper burial. The individual grains or particles of the sediment are packed closer and closer together, thus reducing pore space. Pore waters are forced out and ultimately compaction will result in grain-to-grain suturing. *See also* pressure solution.

companion species Term formerly used in the Braun-Blanquet phytosociological scheme to mean 'indifferent species'. Companion species at the association level sometimes emerge as characteristic

(**kennarten**, or faithful) species when communities are classified at higher levels, such as alliances or orders.

compartment model (box model) Modelling approach which emphasizes the quantities and materials in different compartments of a system, and which may also express connections between compartments by some form of transfer coefficient. The approach is frequently used for studies of whole ecosystems.

compass timber Curved timber, used in shipbuilding.

compensation level Depth at which light penetration in aquatic ecosystems is so reduced that oxygen production by photosynthesis just balances oxygen consumption by respiration. Generally this implies a light intensity of about 1% of full daylight.

compensation point Concentration of carbon dioxide at which there is a balance in a given plant between the amount of carbon dioxide given out by respiratory processes and that taken up by photosynthesis.

compensation sac *See* Ascophora.

competence The ability of moving ice, water, or air to transport the maximum size of rock particle encountered in its path. Ice has a high competence, because of its viscosity; flowing water has a lower competence, though this increases sharply as velocity increases. Wind has the least competence.

competition Interaction between individuals of the same species, or between different species populations at the same trophic level, in which the growth and survival of one or all species or individuals is affected adversely. The competitive mechanism may be direct (active), as in allelopathy and mutual inhibition, or indirect, as when a common resource is scarce. Competition leads either to the replacement of one species by another that has a competitive advantage, or to the modification of the interacting species by selective adaptation (whereby competition is minimized by small behavioural differences, e.g. in feeding patterns). Competition thus favours the separation of closely related or otherwise similar species. Separation may be achieved spatially, temporally, or ecologically (i.e. by adaptations in behaviour, morphology, etc.). The tendency of species to separate in this way is known as the competitive exclusion, or Gause, principle.

competitive exclusion principle (Gause principle) The principle that two or more resource-limited species, having identical patterns of resource use, cannot coexist in a stable environment: one species will be better adapted and will out-compete or otherwise eliminate the others. The concept was derived mathematically from the logistic equation by Lotka and Volterra, working independently, and was first demonstrated experimentally by G. F. Gause (1934) using two closely related species of *Paramecium*. When grown separately, both species populations showed normal S-shaped growth curves; when grown together, one species was eliminated.

competitive inhibition Reversible inhibition of the activity of an enzyme, brought about by the presence of an inhibitor molecule structurally similar to the normal substrate.

complementary genes Mutant alleles at different loci which complement one another to give a wild-type phenotype. Dominant complementarity occurs where the dominant alleles of two or more genes are required for the expression of a particular trait. Recessive complementarity is the case of suppression of a particular trait by the dominant allele of either gene, so that only the homozygous double recessive displays the trait.

complementation map Gene map in which each mutation is represented by a line or 'bar' that overlaps the bars for other mutations with which it will not complement. Non-complementing mutants are represented by overlapping, continuous lines. Each bar probably represents the region of the polypeptide that is distorted by an amino-acid substitution. Complementation maps are usually linear, and the positions of mutants on the complementation and genetic maps usually accord.

complementation test Test to determine whether two mutant sites of a gene are on the same cistron. It is performed by introducing two mutant chromosomes into the same cell and observing whether the wild-type phenotype will be expressed, which it will if each chromosome complements the defect of the other. If complementation occurs, the two sites must be in different cistrons. The genotype of the complementing hybrid would be symbolized as a+/+b. This test is also known as the *cis–trans* test.

complete penetrance The case in which a specified genotype always manifests itself at the phenotypic level. For this to happen, not only must a dominant gene always produce a phenotypic effect; so must a recessive gene in the homozygous state.

complex-gradient Gradient of environmental factors linked in a complex fashion, e.g. the interrelated changes in rainfall, windspeed, and temperature, found along a transect from high to low elevation. *See also* ecocline; *compare* coenocline.

Compositae The largest family of flowering plants, which represent almost every life-form. The flowers are individually small, but are clustered into heads or capitula resembling flowers; the florets are seated on receptacles of varied form, and the heads are surrounded by an involucre, or bracts resembling a calyx. The florets often have no calyx, but sometimes a hairy or scaly pappus develops in the fruit. The corolla is tubular or strap-like, and five-lobed. The five stamens are joined into a tube. The ovary is inferior, and one-celled, forming an achene in the fruit. Some have all the florets similar, either all tubular or all strap-shaped; in some the outer florets are strap-like (e.g. *Bellis*, the daisy), and female or neuter, while the inner florets are tubular and usually hermaphrodite. The family is closely related to the Dipsaceae (which, however, has long, usually free stamens, conspicuous calyx teeth, a cup-like epicalyx to each flower, and the ovule pendulous, instead of basal, in the ovary).

The family includes the largest Angiosperm genus, *Senecio* (ragworts and groundsels), of more than 2000 species; and many valuable cultivated plants, e.g. *Lactuca sativa* (lettuce), *Helianthus tuberosus* (Jerusalem artichoke), *Tragopogon porrifolius* (salsify), as well as oil-producing plants, e.g. *Helianthus annus* (sunflower), and many garden plants and serious weeds. The family consists of nearly 1000 genera, with perhaps 30 000 species, with a cosmopolitan distribution.

compound eye Eye that is made up of ommatidia. The number of ommatidia may vary from a few dozen in some insects to several thousand in animals with good eyesight, e.g. bees and dragonflies. Many insects and crustaceans, some chelicerates, and a few annelids have compound eyes. *See also* ommatidium.

compressed body of fish *See* depressed body of fish.

Comulatida (feather-stars; class Crinoidea, subclass Articulata) Order of crinoids which lack a stem or column in the adult state and which swim freely. The uppermost ossicle of the column is modified into a conical or discoidal plate (a centrodorsal). This bears numerous cirri, which are used to grasp substrata. The order has existed from the Jurassic to Recent.

conchoidal fracture Curved fracture pattern characteristic of some siliceous minerals, e.g. quartz, fine-grained igneous rocks, and volcanic glasses, especially obsidian.

Conchorhagida (phylum Aschelminthes, class Kinorhyncha) Order of platyhelminth worms in which the head is covered on retraction by two plates on the third body segment.

Conchostraca (clam shrimps; phylum Arthropoda, subphylum Crustacea, class Branchiopoda, order Diplostraca) Suborder of branchiopod crustaceans called 'clam shrimps' because the body is almost or completely enclosed in a bivalved carapace, which is folded, rather than being hinged dorsally. A transverse adductor muscle closes the two valves of the carapace. The compound eyes are sessile, and the second antennae are well developed, biramous, and setose, and augment the trunk limbs in locomotion. There are 10–32 trunk segments, each with a pair of appendages. There are 180 species.

concolorous Of the same colour (as some other specified structure).

concolour *See* Hylobatidae.

concordant intrusion Igneous intrusion that has been emplaced parallel with the structure (bedding, foliation, etc.) of the invaded country rock. Sills are examples of concordant intrusions.

concrescent Applied to the union of organs that are usually separate, e.g. petals with each other or with stamens (which are then termed 'epipetalous').

concrete minimum temperature An alternative to the grass minimum temperature, producing more uniform results, and relevant to the likely freezing on road surfaces, etc. The temperature is recorded by a standard thermometer exposed in contact with a concrete surface.

concretion 1 (geol.) Roughly spherical or ellipsoidal body, produced as a result of local early cementation within a sediment. It is often found with a fossil as a 'nucleus'. The size ranges from approximately 1 mm to more than 1 m, and concretions are generally monomineralic. 2 (pedol.) Localized concentration of material, e.g. calcium carbonate or iron oxide, in the form of a nodule of varying size, shape, or colour.

condensation level The atmospheric level at which condensation occurs as a result of convection, the lifting of air, or vertical mixing. *See also* lifting condensation level; and convective condensation level.

condensation nucleus Small particle of an atmospheric impurity (e.g. salt, dust, or smoke), which provides surfaces for the condensation of water. Nuclei vary in size from about 0.1 μm to more than 3 μm. Some nuclei, e.g. salt and acid particles, can encourage condensation at a relative humidity well below 100%. *See also* Aitken nucleus; condensation; and hygroscopic nuclei.

condensation trail (contrail) Broadening trail of water droplets or ice particles behind an aircraft, caused by the release of water vapour by the engines. *See also* dissipation trail.

conditional instability Atmospheric condition in which otherwise stable air, on being forced to rise (e.g. over an orographic barrier), cools at a rate less than that at which the temperature drops with height in the surrounding air. The rising air therefore becomes warmer than the surrounding air, and so continues to rise. This lesser rate of fall of temperature in the rising air is due to the condensation that occurs, as this is accompanied by a release of latent heat of condensation. In such cases the instability is thus conditional upon the relative humidity of the rising air. *See also* instability.

conditioning (ethol.) Form of learning in which an animal comes to associate a significant stimulus (e.g. the smell of food) with a neutral stimulus (e.g. a sound) that precedes it, so that the previously neutral stimulus evokes a response appropriate to the significant stimulus.

condors *See* Cathartidae; and *Vultur* (Andean condor).

conduplicate *See* vernation.

Condylarthra (class Mammalia, subclass Theria, infraclass Eutheria, cohort Ferungulata, superorder Protoungulata) Extinct order comprising seven families of primitive ungulates, including some resembling the original eutherian stock so closely that their classification has presented many difficulties. Condylarths appear to be transitional between insectivores and true ungulates. They ranged from the late Cretaceous to the latter part of the Miocene and were a major part of the Palaeocene fauna. Some forms possessed claws and may have been arboreal (Hyopsodontidae), others became highly specialized, but the development of hoofs and ungulate dentition can be traced to families in the order.

condyle Knob of bone, round or ellipsoid in shape, that fits into a socket of an adjacent bone to form a joint.

condylobasal length The length of a skull, measured from the anterior points of the premaxillary to the occipital condyles.

cone 1 Inflorescence of Coniferae. **2** *See* volcano.

cone-headed grasshopper *See* Tettigoniidae.

coneworms *See* Sedentaria.

conflict (ethol.) Motivations that urge an animal to perform more than one activity at a time. Conflict may lead to one motivation becoming dominant, or to unresolved, ambivalent behaviour, or to irrelevant behaviour.

confluence Of air flow, convergence of adjacent streamlines, which increases air velocity. *See also* convergence.

conger eels *See* Congridae.

congestus From the Latin *congestus* meaning 'piled up', a species of cumulus cloud with deep bulging form and an upper part having a cauliflower-like appearance. *See also* cloud classification.

Congiopodidae (pigfish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of fairly deep-bodied marine fish in which the head has a steep profile, and a produced, pig-like snout. The long and continuous dorsal fin originates above the eyes. There are about seven species found in the colder waters of the southern hemisphere.

conglomerate Coarse-grained (rudaceous) rock with rounded clasts that are greater than 2 mm in size. Conglomerates may be termed intraformational if formed of local, recently deposited clasts, or extraformational if the clasts are derived from outside the area of deposition. The term 'polygenetic' is used to describe a conglomerate rock that has been produced under a variety of conditions or processes.

Congo eel *See* Amphiumidae.

congolli (*Pseudaphritis urvilli*) *See* Bovichthyidae.

Congridae (conger eels; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Large family of marine fish which in profile resemble the common eels. However, the dorsal fin of the congers originates above the tip of the pectoral fin. The skin bears no scales, whereas the common eels possess minute scales. Congers live mainly in rocky coastal waters and are voracious predators. *Conger conger* (Atlantic conger) is of some importance to W. European fisheries. The larger females can exceed 2 m in length. There are about 100 species, with a worldwide distribution.

Congrogadidae (eelblennies; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have elongate to eel-like bodies, and long dorsal and anal fins; the pelvic fins may be absent. There are about eight species, occurring in the Indo-Pacific region.

conidiophore Specialized hypha upon which one or more conidia are borne.

conidiospore *See* conidium.

conidium (conidiospore) Thin-walled spore produced asexually by many types of fungi.

Coniferae The most important and biggest group of gymnosperms, with a long fossil history, comprising trees, nearly all of which are evergreen, commonly with monopodial crowns. Most are resinous. The wood lacks vessels. Conifers are extremely important for timber and paper production. The leaves are often needle- or scale-like. Fertile parts occur in unisexual cones, variously containing sterile scales. Stamens are borne on commonly peltate scales. The ovule and seed are naked, and borne on a scale. There are 6–8 families, with about 50 genera, and 400 species.

Coniferales (conifers) Order of the Coniferopsida, one of three subdivisions of the gymnosperms. They have needle-, fan-, or paddle-shaped leaves, separate male and female cone-like inflorescences, and first appear as fossils in Carboniferous rocks. Although still an important group of trees, as native plants they are far less widely distributed and numerous than they were formerly, but are of great importance in commercial forestry, especially in temperate climates.

Coniferopsida Subdivision of the gymnosperms, comprising four orders. The oldest of them, the Cordaitales, appeared in the Carboniferous. They became extinct at the end of the Permian, but their place was taken by two other coniferopsid orders: the Ginkgoales (ginkgos) and Coniferales (conifers). The ginkgos are now limited to one species, and the conifers have also undergone much reduction as a group. This is also true of the Taxales (yews), the youngest of the coniferopsid orders.

conifer woodland Woodland in which not less than 80% of the standing trees are coniferous.

Coniophora (family Coniophoraceae) Genus of fungi in which the fruit bodies are resupinate and more or less convoluted. In *C. puteana* (*C. cerebella*) the fruit bodies are thin, flattened, irregular in shape, and initially creamy-white, becoming greenish-yellow on maturation. This species is common on wet, decaying wood, and on timbers in damp buildings.

Coniophoraceae (order Aphyllophorales) Family of fungi in which the spores are coloured, smooth, and have double-layered walls. There are eight genera. The family includes some important timber-rotting fungi.

conjugated protein Protein that contains a non-protein component, which may be a metal ion or an organic substance.

conjugation Process whereby organisms of identical species (but opposite mating types) pair and exchange genetic material (DNA): i.e. each individual both gives and receives material. This process of sexual reproduction is found only in unicellular organisms such as bacteria and Protozoa, although it is sometimes also applied to the union of gametes, particularly in isogamy (found in fungi, some green algae, and Protozoa). Details of

the process differ greatly between different organisms. For example, in bacteria only DNA is transferred from one cell to another, while in some eukaryotic microbes the process may involve the fusion of two entire protoplasts. The transfer of DNA may be unidirectional (as in the case of *Escherichia coli*), in which case one cell is called the donor and the other the recipient, or bidirectional (as in *Paramecium aurelia*).

conk Term used by foresters and woodcutters to refer to the fruit bodies of certain wood-rotting fungi, particularly those of polypores.

Connaraceae Family of mostly woody climbing plants in which the leaves are usually pinnate, without stipules. The flowers are pentamerous. The fruit is usually a one-seeded follicle, the seed arillate. There are 25 genera, with 200 species, occurring generally throughout the tropics.

connective tissue In vertebrates, supportive or packing tissue composed of fibres, mainly of white collagen but with some made from more elastic, yellow material, containing scattered cells and blood and lymph vessels, all lying in a matrix containing polysaccharide (starch-like carbohydrate). *See also* adipose tissue.

Connemara clingfish (*Lepadogaster candollei*) *See* Gobiesocidae.

connexivum In many Hemiptera (true bugs), the series of laterotergites along the sides of the abdomen, the laterotergites being a pair of sclerites which flank each of the main abdominal tergites.

Conocardioida (phylum Mollusca, class Rostroconchia) Order of distinctive rostroconchs which have an elongated posterior portion to the shell. There are definite ribs on both inner and outer surfaces of the shell. The order ranges in age from Lower Ordovician to Upper Permian.

Conocephalum (order Marchantiales) Genus of robust, thallose liverworts. *C. conicum* has a broad, ribbon-like thallus which is irregularly forked and up to 20 cm long and 1.5 cm wide. The upper surface is perforated with pores which are quite clearly visible to the naked eye; each pore occurs at the centre of a hexagonal marking beneath which is an air chamber (areola). These liverworts are common on rocks, and on soil in habitats that are both moist and somewhat shaded, e.g. on banks of streams and ditches.

Conocybe (family Bolbitiaceae, order Agaricales) Genus of fungi which form mushroom-shaped fruit bodies with a regular cap and central stipe. The gills are yellowish to cinnamon-coloured. The spore-print is bright rusty brown in colour. They are found mostly in grassy places.

Conopidae (thick-headed flies; class Insecta, order Diptera, suborder Cyclorrapha) Family of rather elongate, medium-sized flies, which have a long, often jointed proboscis, used to obtain nectar from flowers. The palps are reduced and the ptilinal groove is sometimes shortened. Cell Cu_2 is long and may reach the wing margin (*see* venation). The male sixth, seventh, and eighth abdominal tergites are lost, exposing the genitalia. The abdomen may be down-curved posteriorly. In general, the adults resemble bees and solitary or social wasps in colour and appearance, and may be mistaken for them. Their eggs are specially adapted to cling to host wasps, on which the larvae will feed as endoparasites. Adult conopids are regular visitors to flowers. The family is distributed throughout the world, and there are more than 800 species.

Conopophagidae (gnateaters; order Passeriformes) Family of small, short-tailed, long-legged birds, mainly brown above and white below, many having a white post-ocular stripe. They are secretive and ground-feeding insectivores, building nests at the base of bushes. There is one genus, with eight species, often placed with the Formicariidae, found in S. America.

Conrad discontinuity In geophysics, a boundary within the Earth's continental crust that can be detected seismically, although exploratory deep drilling has failed to locate it. The boundary separates the crust into a lower, basic and an upper, granitic layer. *See also* sial; and sima.

consanguinity (adj. consanguineous) Genetic relationship in which individuals share at least one ancestor in the preceding few generations. Matings between related individuals may reveal deleterious recessive alleles. For example, first-cousin marriages amongst humans account for about 18–24% of albino children and 27–53% of children with Tay–Sachs disease, both of which rare recessive conditions.

consequent stream Stream whose course is consequent upon the shape of a newly-emerged land surface. Its course shows no necessary relationship with the underlying geological structure, although older usage tended to restrict the term to a stream flowing in a downdip direction across gently inclined strata.

conservation The maintenance of environmental quality and resources. The resources may be physical (e.g. fossil fuels), biological (e.g. tropical forest), or cultural (e.g. ancient monuments). In modern scientific usage conservation implies sound biosphere management within given social and economic constraints, acknowledging the naturally dynamic character of biological systems. This contrasts with the preservationist approach which, it is argued, protects species or landscapes without reference to natural change in living systems. *See also* biological conservation.

consistence (consistency) The resistance of soil to physical impact such as ploughing, digging, or handling. It is controlled by the degree of adhesion between soil particles. It is described when dry as loose, soft, or hard, when moist as loose, friable, or firm, and when wet as sticky, or plastic.

consistency *See* consistence.

consociation Phytosociological term of the British and American traditions, meaning a community with a single dominant species, e.g. an oak or beech wood. The term is also used by the Uppsala school.

consocies Term, little used, derived from the Clementsian scheme for vegetation classification, and referring to a seral community in the succession to a climax community with the consociation status. *See also* phytosociology.

conspecific Applied to individuals that belong to the same species.

constancy *See* constant species.

constant species (constancy) (ecol.) In phytosociology, a species common to a particular association or community, but not necessarily confined to that community; a species of wide ecological amplitude compared with a faithful species. A species of high constancy would be present in all, or almost all, of a series of relevés or field samples that describe an association or community.

constellation diagram Representation of species affinities based on χ^2 as a measure of the association between species. The reciprocal of the χ^2 value for each species pair is used to plot the diagram, so that highly positively associated species with large χ^2 values are positioned closely together. Thus clusters of similarly distributed species may emerge, while the transitional affinities of a species with those of another main focal area or cluster will be evident. The constellation diagram exemplifies a simply calculated ordination method.

constitutive enzyme Enzyme that is always produced whether or not a suitable substrate is present. Such enzymes are sometimes produced by particular regulatory mutants which, though not affecting the structure of the enzyme, instead affect the process by which its synthesis occurs. An example is the *lac*-operon, which controls the synthesis of three enzymes (betagalactosidase, permease, and acetylase): enzymes that are involved in the lactose metabolism of the bacterium *Escherichia coli*.

constricting snakes *See* Boidae.

constructive wave Wave that leads to the build-up of a beach due to the swash of the wave being more effective in moving material than the backwash. Flat waves usually have a more powerful swash than backwash. Usually, constructive waves are associated with low-energy conditions and a gentle offshore gradient.

consumer organism In the widest sense, a heterotrophic organism that feeds on living or dead organic material. Two main categories are recognized: (a) macroconsumers, mainly animals (herbivores, carnivores, and detritivores), which wholly or partly ingest other living organisms or organic particulate matter; (b) microconsumers, mainly bacteria and fungi, which feed by breaking down complex organic compounds in dead protoplasm, absorbing some of the decomposition products, and at the same time releasing inorganic and relatively simple organic substances to the environment. Sometimes the term 'consumer' is confined to macroconsumers, microconsumers being known as 'decomposers'. Consumers may then be termed 'primary' (herbivores), 'secondary' (herbivore-eating carnivores), and so on, according to their position in the food-chain. Macroconsumers are also sometimes termed phagotrophs or biophages, while microconsumers correspondingly are termed saprotrophs or saprophages. *Compare* producer; and decomposer.

consummatory In animals, applied to behaviour associated with the achievement of a goal (e.g. the eating of food) as distinct from appetitive behaviour (e.g. searching for food).

consumption Common name for the pulmonary form of tuberculosis.

contact inhibition The cessation *in vitro* of both movement and replication in a cell on making contact with other cells, such that a confluent monolayer is formed in the culture. Probably it occurs as a result of the formation of cytoplasmic bridges between cells. In many cancer cells this inhibition is absent.

contagious Usually applied to a disease that can be transmitted from one person to another only by physical contact, but may also be applied to any communicable disease.

contagious abortion (Bang's disease) Abortion in cattle that results from infection with a species of *Brucella* (usually *B. abortus*). *See also* brucellosis.

contagious distribution *See* overdispersion.

Contarinia pyrivora (pear midge) *See* Cecidomyidae.

contessa del vento Type of cloud typically with a rounded base and bulging upper surface. Sometimes a number of separate discs of this cloudform extend one above another. Such cloud occurs on the lee side of distinct mountains within an eddy zone. In the case of Mount Etna the cloud is related to a westerly air stream.

context (mycol.) Tissue that constitutes a fungal fruit body.

contiguous grids System of adjacent quadrats. *See also* grid analysis of pattern.

continental drift Hypothesis proposed to describe the relative movements of continental masses over the surface of the Earth. A major theorist of continental drift, and certainly the one who gave the hypothesis scientific plausibility, was Alfred Wegener (1880–1930). His work was based on qualitative data, but more recently it has been strongly supported by the development of the plate-tectonics theory, which has provided geologists with a viable mechanism to account for continental movements.

continentality A measure of how the climate of a place is affected by its remoteness from the oceans and oceanic air. Most frequently the difference between the average temperatures prevailing in January and July is quoted as an indicator of this.

continental margin Zone that consists of the continental shelf, slope, and rise. It extends from the shoreline to the deep-ocean floor at a depth of 2000 m. The zone is underlain by continental, or sialic, crust.

continental rise Smooth-surface accumulations of sediment which form at the base of the continental slope. The surface of the rise is gently sloping with gradients between 1 : 100 and 1 : 700. The width of the rise varies but is often several hundred kilometres. Two types of deposit lead to the formation of rises, turbidites laid down by turbidity currents flowing down the continental slope, and contourites laid down by contour currents flowing along the rise at the base of the continental margin.

continental shelf Gently seaward-sloping surface that extends between the shoreline and the top of the continental slope at about 150 m depth. The average gradient of the shelf is between 1 : 500 and 1 : 1000 and, although varying immensely, the average width is approximately 70 km. Five major types of shelves may be recognized: (a) those dominated by tidal action; (b) those dominated by wave and storm action; (c) those dominated by carbonate deposition; (d) those subject to modern glaciation in arctic areas; and (e) those floored by relict sediments which constitute up to 50% of the total shelf area.

continental slope The relatively steeply-sloping surface that extends from the outer edge of a continental shelf down to the continental rise. The total relief is substantial, ranging from 1 km to 10 km, but the slope is not precipitous and ranges from 1° to 15° (average 4°) of slope. Along many coasts of the world the slope is furrowed by deep submarine canyons, terminating as fan-shaped deposits at the base.

continental south-east Asia floral region Part of Good's 1974 Palaeotropical kingdom, which lies within the Indo-Malaysian subkingdom. Floristically it is a poorly documented region, transitional between the rich floras of China to the north and Malaysia to the south. There are relatively few endemic genera, probably around 250, though the proportion of endemic species is thought to be high. This region is very likely the source of such important crop plants as rice, tea, and *Citrus* fruit.

contingency table (two-way table) Table of data for two methods of classification of the same individuals, e.g. hair colour and eye colour. This type of data can then be analysed statistically for association between these properties using a χ^2 test.

continuous distribution Data that yield a continuous spectrum of values. Examples are measurements of wing length of a bird, or weight of a mammal, or height of a plant.

continuous variation An assemblage of measurements of a phenotypic character which form a continuous spectrum of values. Examples are body weight, height, or shape, reproductive rate, and various behaviour traits. The continuity of phenotype is a result of two phenomena: (a) each phenotype does not have a single phenotypic expression but a norm of reaction that covers a wide phenotypic range; (b) there may be many segregating loci whose alleles make a difference to the phenotype being observed.

continuum (ecol.) The idea that vegetation is continuously variable and cannot be classified into discrete entities, since it shows gradual change in response to environmental change. Such change may be analysed using ordination methods, e.g. the 'continuum approach' of the Wisconsin ordination scheme.

continuum index Measure of the total environment of a stand of trees, expressed in terms of species composition and their relative abundance. In the Wisconsin ordination scheme the index is calculated by multiplying the importance value of each species in each sample by the adaptation number, and summing these results for each stand. *See also* climax adaptation number; and importance value.

contour current Undercurrent typical of the continental rise which flows along the western boundaries of ocean basins. Such currents occur particularly in regions in which density stratification is strong because of the supply of cold waters originating near the Poles. A well-known example is the Western Boundary undercurrent which hugs the continental rise of eastern N. America. Contour currents are permanent, slow-moving (velocity 5–30 cm/s) flows capable of transporting mud, silt, and sand.

contourites Sediments that have been deposited by contour currents on the continental rise. The sediments are thin-bedded silts, sands, and muds. The sands are well sorted, laminated, or cross-laminated, with many internal erosion surfaces, and concentrations of heavy minerals. Both bottom and top contacts of the beds are sharp, and the beds lack great lateral continuity.

contractile vacuole Organelle which appears to function in the removal of excess water from the cells of protozoa. The contractile vacuole expands as it fills with water from the cytoplasm, and contracts as this water is emptied to the exterior.

contraction limit *See* Atterberg limits.

contrail *See* condensation trail.

controlled pollination Practice used in plant hybridization. Pistillate flowers are enclosed in bags (usually of muslin) to protect them from unwanted pollen: when they are in a receptive condition, the flowers are dusted with pollen of the required type. This is commonly performed in horticulture and in genetic experiments.

controlling gene Gene that is involved in turning on or off the transcription of structural genes. Two types of genetic element exist in this process: a regulator and a receptor element. A receptor element is one that can be inserted into a gene, making it a mutant, and can also exit from the gene (the mutation is thus unstable). Both of these functions are under the influence of the regulator element, and are non-autonomous.

Conulariida (phylum Cnidaria) The only order of the subclass Conulata, that has the characteristics of the subclass. The order is divided into two suborders, four families, three subfamilies, and 20 genera.

Conulata (class Scyphozoa) Extinct subclass of Cnidaria whose members had tetramerous symmetry; a conical to elongate pyramidal or subcylindrical shape; a thin chitinophosphatic periderm; and tentacles around the mouth. They are Middle Cambrian to Triassic in age.

conures *See Pyrrhura*.

Convallaria (lily-of-the-valley; family Liliaceae) Genus of plants which have long-stalked, oval leaves in pairs, and leafless, one-sided spikes of white, globose to bell-shaped, six-lobed flowers. The fruit is a red, globular berry. There are three species, occurring in northern temperate regions.

convection 1 Vertical circulation within a fluid that results from density differences caused by temperature variations. Convection currents occur in the oceans when a water mass that is colder than water below it tends to sink and be replaced by lighter, warmer water. 2 In meteorology, the process in which air, having been warmed close to the ground, rises. The convective uplift of air parcels is one of the main processes leading to condensation and cloud formation. *See also* dishpan experiment; forced convection; Hadley cell; instability; level of free convection; and stability.

convection current *See* convection (1).

convective cell The pattern formed in a fluid when local warming causes part of the fluid to rise, and local cooling causes it to sink again elsewhere. The atmosphere in low latitudes forms such cells, known as Hadley cells, as warm equatorial air rises, moves away from the equator and cools, and then descends over the subtropics.

convective condensation level The level at which surface air will become saturated when rising by convection. *See also* lifting condensation level.

convective instability *See* potential instability.

convergence Situation in which, over a given lapse of time, more air flows into a given region than flows out of it. It is commonly accompanied by confluence of the streamlines, but may be caused by differences of velocity, e.g. where the wind comes against a coast or a mountain wall. Surface friction can produce convergence. *Compare* divergence.

convergent evolution The development of similar external morphology in organisms which are unrelated—except through distant ancestors—as each adapts to a similar way of life. Sharks (fish), dolphins (mammals), and icthyosaurs (extinct reptiles) provide good examples of convergence in the aquatic habitat.

convolute *See* vernation.

Convolvulaceae Family mostly of twining herbs, but with some trees and shrubs in which the flowers are regular, with five sepals, and a five-lobed corolla which is often showy, bell- or funnel-shaped, and hardly lobed. There are five stamens fixed to the corolla tube. The ovary is superior, and one- to four-celled. The fruit is a capsule, or (rarely) fleshy. There are 40 genera, with 1000 species, occurring mainly in tropical but also in temperate regions.

cony Common name applied originally to rabbits, but sometimes also to the hyrax (e.g. in the Bible). More correctly, the name is now reserved for the pika. *See also* Hyracoidea; and Ochotonidae.

Conyza (family Compositae, tribe Astereae) Genus of annual or perennial herbs which have simple leaves arranged in a spiral along the stem. The flower heads are usually held in clusters or corymbs. The central florets are bisexual, and the outer ones female, with tubular, simple corollas. There are no broad petals in the ray florets. The achenes are usually softly hairy and compressed, with a simple row of pappus hairs. Many species are N. American weeds. There are about 60 species, found in temperate and subtropical regions.

Cooksonia hemispherica (family Rhyniaceae) Extremely primitive plant from the Upper Silurian and Lower Devonian. Members of the family did, however, possess an epidermis and stomata to control the passage of gases. They also had an underground rooting portion, the rhizome, and they branched dichotomously. *C. hemispherica* is the first representative of the Rhyniaceae, and is known from the Silurian of Europe.

Cooktown salmon (*Eleutheronema tetradactylus*) *See* Polynemidae.

Cooloola monster (*Cooloola propator*) *See* Cooloolidae.

Cooloola propator (Cooloola monster) *See* Cooloolidae.

Cooloolidae (class Insecta, order Orthoptera, suborder Ensifera) Family of cricket-like insects, which was first described in 1980 and is known from only one genus and species, *Cooloola propator* (Cooloola monster), found in SE Queensland, Australia. Its common name refers to its remarkable, robust form, and it is unusual among ensiferans in having short antennae with 10 segments. The structure of the mouthparts is unique among Orthoptera. *C. propator* lives in sandy, moist soil. Males wander about on the surface at night, but females appear to be wholly subterranean.

coombe rock *See* head.

co-operation In animals, mutually beneficial behaviour involving several individuals (e.g. collaborative hunting, and care of the young. Co-operation may involve altruism. Co-operation among members of different species is usually called 'symbiosis'.

co-operativity Interaction between binding sites within a protein molecule whereby the binding of a ligand to one site influences the affinity of other sites on the same molecule for further ligands.

cootie (*Pediculus capitis*) *See* Pediculidae.

coots *See Fulica*; and Rallidae.

Copepoda (phylum Arthropoda, subphylum Crustacea) Large and diverse class of mostly marine Crustacea, though there are many freshwater species and a few which live in water films between mosses and soil particles. Many are ectoparasites of

fish and whales. In free-living forms, the body is usually short and cylindrical, the 10-segmented trunk comprising a thorax and an abdomen. The head may bear a pointed rostrum, or be rounded anteriorly. A median nauplius eye is typical of all copepods, as is the absence of compound eyes. The first antennae are uniramous, and well-developed; the second pair are smaller. The first pair of thoracic appendages are feeding structures and are modified to form maxillipeds. With the exception of the last one or two pairs, the remaining thoracic appendages are similar, and symmetrically biramous. The posterior of the head is fused to the first thoracic segment and also, occasionally, to the second. The tapered thorax comprises 3–5 unfused segments with appendages. The narrow, cylindrical abdomen is devoid of appendages; the anal segment bears two caudal rami. Many copepods are planktonic, occur in vast numbers, and, as the major food of many marine animals, are the main link between phytoplankton and the higher trophic levels. Most species are tiny, ranging from less than one to several millimetres in length, though the species of *Penellus*, which are ectoparasites of fish and whales, may attain 32 cm or more. There are more than 7500 species of copepods.

copepodid larva Series of larval stages, usually five, following the six nauplius stages in copepod Crustacea. Typically, the first copepodid larva shows no abdominal segmentation, and there may be only three pairs of thoracic limbs. Otherwise, copepodid larvae display the general features of the adult. *See also* Copepoda.

Copernicia (family Palmae) Genus of big, solitary palms which have fan-shaped leaves. The inflorescences are axillary, and much-branched, with subtending tubular bracts. Several species are of spectacular beauty and are in cultivation. *C. cerifera* yields carnauba wax. They occur in the lowland seasonal tropics, three species being found in S. America, two in Hispaniola, and 20 in Cuba.

Cope's rule E. D. Cope (1840–97) noted a phylogenetic trend toward increased body size in many animal groups, including mammals, reptiles, arthropods, and molluscs. Indeed, so common is the trend that it has become known as Cope's rule. While size increase may confer many adaptive advantages, it is by no means universal, even within the same lineage.

copper An element (symbol Cu) that is required in small amounts by plants, although high concentrations of it can be toxic. It is found bound to proteins and is involved in oxidation–reduction reactions, especially those involving molecular oxygen. The signs of copper deficiency can be very varied: leaves may become chlorotic or dark green; the bark of trees may blister; shrubs may become very bushy.

copper glance *See* chalcosite.

copper moss Moss that grows on copper-rich rocks. Such mosses, including species of *Mielichhoferia*, *Dryptodon*, and *Merceya*, can survive levels of copper far in excess of those lethal to other mosses.

copper pyrites *See* chalcopyrite.

coppers *See* Lycaenidae.

coppice 1 Traditional European method of woodland management and wood production, in which shoots are allowed to grow up from the base of a felled tree. Trees are felled in a rotation, commonly of 12–15 years. A coppice may be large, in which case trees, usually ash (*Fraxinus*) or maple (*Acer*), are cut, leaving a massive stool from which up to 10 trunks arise; or small, in which case trees, usually hazel (*Corylus*), hawthorn (*Crataegus*), or sallow (*Salix*), are cut to leave small, underground stools producing many short stems. The system provides a continuous supply of timber for fuel, fencing, etc., but not structural timber. Coppicing is largely abandoned now, except for conservation purposes, since high labour costs and alternative fuels and materials render the practice unprofitable. 2 The smaller trees and bushes that regenerate from cut stumps and occasionally (e.g. in *Ulmus* species) from root suckering. 3 Area of land in which underwood and timber is or was grown. 4 (copse) Any type of wood in which the shrub layer predominates and is periodically coppiced. 5 The action of cutting coppice.

coppiced scrub The regrowth of trees resulting from irregular coppicing.

coppice shoot Shoot that arises from a bud at the base of the stool of a tree that has been cut near the ground.

coppice stump (moot, stool) Remnant of a tree that has been cut, usually to or near to ground level, and from which coppice growth develops.

coppice-with-standards Coppice system in which occasional trees, typically oak (*Quercus robur*) are allowed to grow to their full height (standards) for use as structural timber, while the understorey, typically of hazel (*Corylus avellana*), is coppiced.

copra The endosperm of *Cocos nucifera*. *See also* *Cocos*.

Coprinaceae (order Agaricales) Family of fungi in which the spores in masses appear dark brown, or black. The fruit bodies are often fragile. There are several genera, found on dung, soil, or rotting wood.

Coprinus (family Coprinaceae) Genus of fungi which form mushroom-like fruit bodies. The gills are parallel-sided, and typically liquefy (autodigest) from the lower edge upwards as the spores mature. There are many species. Most are found on dung, but some grow on rotting timber, tree-stumps, etc. Some species are edible. *See also* ink cap.

coprophagy Feeding by the ingestion of faecal pellets that have been enriched by microbial activity during exposure to the external environment. Many detritivores are coprophagic.

coprophilous Growing on or in dung.

Coprosma (family Rubiaceae) Shrubby genus with an interesting geographical distribution (New Zealand, SE Australia, Indonesia, Polynesia, Hawaii, and Juan Fernandez Island), which is

possibly due in part to the separation of continental tectonic plates, but also perhaps to birds eating the unusual fleshy fruits and transporting the seeds.

copse 1 *See* coppice (4). 2 In modern usage, any small wood, particularly a detached wood that is isolated from other woodland.

copse-bank Boundary between areas of land made from an earth bank, especially where the boundary separates an intermittently enclosed coppice within a wood–pasture system.

coquina Clastic or detrital limestone that contains a high proportion of coarse shell debris cemented by calcium carbonate.

Coracias (rollers; family Coraciidae) Genus of blue, green, and chestnut birds named after their somersaulting display flight. *C. abyssinica* (Abyssinian roller) has greatly elongated outer tail feathers. These rollers are insectivorous, often dropping on to their prey from an exposed perch. There are eight species, found in Europe, Africa, and S. Asia.

Coracias abyssinica (Abyssinian roller) *See Coracias*.

Coraciidae (rollers; order Coraciiformes) Family of brightly coloured birds with short necks, long wings and stout, slightly hooked bills. Their tails are quite long, some species having long outer tail feathers. Their legs are short, with the second and third toes joined basally. They are arboreal and mainly insectivorous, nesting in holes in trees and banks. Some are migratory. There are two genera, with 11 species, found in Europe, Africa, and from S. Asia to Australasia.

Coraciiformes (kingfishers, todies, motmots, bee-eaters, rollers, hornbills, hoopoes; class Aves) Order of 10 families of birds in which the three anterior toes are united. Most nest in holes and lay white eggs. The order comprises the families Alcedinidae, Todidae, Momotidae, Meropidae, Leptosomatidae, Coraciidae, Brachypteraciidae, Upupidae, Phoeniculidae, and Bucerotidae.

Coracina (cuckoo-shrikes, greybirds; family Campephagidae) Genus of mainly grey and white birds, some with barred under-parts. They are found, occasionally in groups, in forests and open country, feeding on insects. They build an open cup nest in trees. There are 41 species found from S. Asia to Australasia, and on many Pacific Ocean islands.

coracoid In the shoulder girdle of vertebrates, a bone on the ventral side extending from the scapula to the glenoid cavity. In mammals other than Monotremata it is reduced to a small process of the scapula.

coral-billed nuthatch (*Hypositta corallirostris*) *See* Hyposittidae.

Corallimorpharia (subclass Zoantharia) Order of solitary or colonial anemone-like polyps. They lack a skeleton, and the radially arranged tentacles terminate in a small knob.

Corallinaceae (order Cryptonemiales, class Rhodophyceae) Family of red seaweeds, most of which are heavily impregnated with lime, and hard and brittle. There are many genera. Some have a crustose thallus which adheres closely to rocks or to other plants. *Corallina* has an erect, branching thallus that is characteristically jointed; *C. officinalis* is a common species fringing rock pools in the intertidal zone. Members of the family are found in all regions, from the arctic to the tropics. Some form important constituents of atolls and coral reefs, being able to survive pounding by surf better than true corals.

corallite The skeleton formed by an individual coral polyp, which may be either solitary or part of a colony.

coral reef Massive, wave-resistant structure built largely by coral (Coelenterata), and consisting of skeletal and chemically precipitated material.

corals 1 (black coral) *See* Antipatharia. 2 (branched hydrocorals) *See* Stylasterina; Tabulata; and Telestacea. 3 (hydrocorals) *See* Hydrocorallina. 4 (massive hydrocorals) *See* Milleporina; and Octocorallia. 5 (soft corals) *See* Alcyonacea; Anthozoa; Astrocoeniina; Caryophylliina; Coenothecalia; Cnidaria; Dendrophylliina; Faviina; Fungiina; Heterocorallia; and Holaxonia. 6 (stony corals) *See* Madreporaria. 7 (tetracorals) *See* Rugosa; Scleraxonia; and Stolonifera.

coral snakes (order Squamata, suborder Serpentes (Ophidia), family Elapidae) Venomous snakes which are characterized by bright coloration, generally in bands running around the body. They occur in the New World, but the name is sometimes applied to African and Asian forms of similar appearance. The warning coloration of the American genus *Micrurus* is mimicked by a harmless pipe snake *Anilius scytale* (family Aniliidae).

coral spot Common name for the coral-pink conidial pustules formed by the fungus *Nectria cinnabarina* on twigs, branches, etc.

corbiculum Area on the outer face of the hind tibia of female bees of the family Apidae, which is specialized for the transport of pollen and of nest-building materials, e.g. resin, mud, or dung. The corbiculum comprises a smooth, shiny depression fringed by stiff bristles, into which pollen or building materials are compacted for transport to the nest. The corbiculum is absent in apids which live as cuckoo bees. *See* Apidae.

Corchorus capsularis *See* Tiliaceae.

Corcoracidae *See* Grallinidae.

cord Stack of wood, usually measuring 2.54 m (8 ft. 4 in.) long by 1.27 m (4 ft. 3 in.) high, but with local variations. It is usually composed of small-diameter material. A cord of this size measures about 3.6 m^3 (128 cu. ft.) when stacked, and contains 2–2.8 m^3 (75–100 cu. ft.) of wood. A 'short cord' is equal to half a cord.

Cordaitales Extinct gymnosperm order, included in the Coniferopsida, which appeared in early Carboniferous times and disappeared towards the end of the Permian. They produced trees up to 30 m high, with strap-like leaves, and primitive cones.

cordierite Mineral, specific gravity 2.5–2.8, hardness 7.0, and with the chemical composition $(Mg,Fe)_2Al_2Si_5O_{18}$, named after the French geologist P. L. A. Cordier, which occurs in aluminous rocks that have been subjected to thermal or regional metamorphism. It occurs in hornfels, schists, and gneisses, in association with andalusite, spinel, quartz, and biotite. Its most distinguishing feature is its colour, which is dark blue or greyish-blue. It is translucent to transparent, and has a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are rare: they can be prismatic, or pseudo-hexagonal, but they are usually massive. Fine examples of dark blue colour are used as gemstones.

cordillera 1 Broad assemblage of mountain ranges belonging to orogenic belts of different ages which formed originally at destructive plate margins. 2 System of mountain ranges, together with their related plateaux and intermontane basins. For example, the Cordillera of N. America includes all the mountain ranges and plateaux west of the Great Plains and of the Mexican lowlands. 3 Subsidiary complex of ranges within a mountain system, e.g. the eastern and western cordillera of the Andes. 4 Individual range, e.g. the Cordillera Patagonica of the S. Andes.

Cordulegaster boltonii (golden-ringed dragonfly) *See* Cordulegasteridae.

Cordulegasteridae (dragonflies; order Odonata, suborder Anisoptera) Small family of large, black and yellow dragonflies, in which the anal loop in the wings is compact but well developed, and the posterior corners of the hindwings are sharply angled in the male. Females have spade-like ovipositors which they use to deposit eggs in stream beds. The larvae are elongate and hairy, and lurk in the silt of streams. There are 75 described extant species, found in the Palaearctic, SE Asia, and N. America. *Cordulegaster boltonii* (golden-ringed dragonfly) is large, conspicuous, and immediately recognizable by the prominent yellow bands on its otherwise black abdomen. The female has a large, pointed ovipositor, which makes this the longest-bodied Eurasian species of dragonfly. It is commonly found near gravel-bottomed streams.

Corduliidae (dragonflies; order Odonata, suborder Anisoptera) Cosmopolitan family of medium-sized dragonflies which have slender, often metallic-green bodies. They have a slight projection on the rear margin of the compound eye, and a foot-shaped anal loop on the wings. The nymphs occur in a wide variety of aquatic habitats, and are difficult to distinguish from those of the Libellulidae. More than 200 extant species have been described.

cordwood Small-diameter wood that has been cut into lengths suitable for use as domestic fuel or for making charcoal.

Cordylidae (girdle-tailed lizards, plated lizards; order Squamata, suborder Sauria (Lacertilia)) Family of terrestrial, insectivorous lizards, the majority of which have transverse rows of ossified, rectangular scales, which may be elongated into spines. Some species are flattened and can enter rock crevices, others are snake-like with reduced limbs. There are about 50 species, occurring in the African savannah. *See also Cordylus giganteus.*

Cordyline (family Agavaceae) Genus of plants which are unusual among monocotyledonous plants in possessing woody stems. The leaves are narrow and tufted; some yielding useful fibre, others decorative. There are 15 species, occurring in the tropics and warm-temperate regions.

Cordylus giganteus (sungazer, Lord Derby's zonure, giant girdled lizard; order Squamata, suborder Sauria (Lacertilia), family Cordylidae) Species of spiny lizard which grows up to 40 cm long, and has a triangular head, powerful limbs, and a sturdy body. Large curved spines protect the neck, back, and tail. It occurs in dry, rocky regions of S. Africa.

core The central zone or unit of the Earth. It is composed of nickel–iron, and accounts for 16% of the Earth's volume and 32% of its mass. The core is separated into inner and outer units. The inner core is a solid with a radius of 1220 km and the outer core, which does not permit the passage of shear (or S) waves, is liquid.

core area Part of a range in which an animal or group of animals may rest securely, in which young may be raised, and to which in some species food may be taken to be eaten. It is likely to be defended against members of the same species that do not share the range.

Coreidae (order Hemiptera, suborder Heteroptera) Family of bugs which feed on the shoots, buds, fruits, and unripe seeds of many plants throughout the world. The family includes the N. American squashbug, which is a pest of pumpkins and related plants. There are about 2000 species.

coremium (mycol.) Sheaf-like bunch, or fascicle, of hyphae or conidiophores.

co-repressor Metabolite that in conjugation with a repressor molecule binds to the operator gene present in an operon and prevents the synthesis of a repressible enzyme.

corestone Rounded boulder, occurring individually or in piles at the ground surface, or in exposed sections. It results from an initial phase of subsurface rounding, by chemical weathering, of a joint-bounded block, followed or accompanied by surface erosion that exposes the corestone.

coriaceous Having a leathery texture.

Coriariaceae Family of dicotyledonous shrubs of one genus (*Coriaria*) with imbricate sepals; persistent, internally keeled petals to the regular flowers; and 5–10 free carpels, which form a fruit of several cocci enclosed in the enlarged petal bases. The family has an interesting geographical distribution, in New Zealand, New Guinea, SE Asia, Japan, SW Europe, and western S. and C. America.

Coriolis force An apparent force acting on moving objects: it results from the Earth's rotation. It causes objects in motion, and oceanic and atmospheric currents, to be deflected to the right in the

northern hemisphere and to the left in the southern hemisphere. The deflection is proportional to the speed and latitude of the moving feature, and therefore varies from zero at the equator to a maximum at the poles.

Coriolus (family Polyporaceae) Genus of fungi in which the hymenium lines tubes that open in small, irregular pores on the under-side of a typically bracket-like fruit body. There are about 20 species, all found on wood. *C. versicolor* (*Trametes versicolor*, *Polystictus versicolor*) is very common on dead wood of broad-leaved trees. The fruit bodies often grow in tiers, and are thin, semicircular brackets with a velvety upper surface usually marked with concentric bands of yellow, brown, grey, etc; the margin and lower surfaces are white.

Corixidae (order Hemiptera, suborder Heteroptera) Family of aquatic bugs which, like the Notonectidae, swim by means of the hair-fringed hind pair of legs; unlike Notonectidae, they swim with their backs uppermost. They filter edible animal and vegetable matter from the debris at the bottom of ponds with their scoop-shaped and bristle-fringed front pair of legs. There are more than 200 species distributed worldwide.

cork In woody plants, a layer of protective tissue that forms below the epidermis. It comprises dead cells, derived from the cork cambium (phellogen), and coated with a waxy substance (suberin) that renders them waterproof. Cork develops abundantly in the bark layer of certain plants, e.g. *Quercus suber* (cork oak), and is removed for commercial use. *See also Quercus*.

corkwood *See Duboisia*.

corm In plants, an underground storage organ formed from a swollen stem base, bearing adventitious roots and scale leaves. Often it is renewed annually, each new corm forming on top of the preceding one. It may function as an organ of vegetative reproduction or in perennation.

cormidium In Siphanophora, an assemblage of polyps of different forms. Often the assemblage is repeated along the stem.

cormorants *See* Pelecaniformes; Phalacrocoracidae; and *Phalacrocorax*.

Cornaceae Family of trees, shrubs, and a few herbs, which are closely related to the Umbelliferae in having umbellate or panicled inflorescences; an inferior, usually two-celled ovary, with one ovule in each cell; and tetra- or pentamerous flowers; but, unlike the Umbelliferae, they have leaves which are usually opposite and entire, and fruits which are fleshy. *Aucuba* and *Cornus* species are cultivated for ornament. There are 15 genera, with about 100 species, mostly northern temperate in distribution, but also occurring in Africa, S. America, New Zealand, and SE Asia.

corncrake *See Crex*.

cornetfish *See* Fistulariidae.

corn salad (*Valerianella*) *See* Valerianaceae.

corolla Collective term for all the petals of a flower. The corolla is a non-reproductive structure, often arranged in a whorl. It encloses the reproductive organs and, with the sepals when present, protects them. Petals are often brightly coloured, and attract pollinating animals.

corona 1 Series of petal-like structures in a flower, either outgrowths of the petals or modified from the stamens. 2 Coloured rings of lights, typically from blue inside to red outside, that sometimes appear to surround the Sun or Moon. The effect is created by diffraction of light by spherical water drops in such clouds as altocumulus. *Compare* halo.

Coronata (subclass Inadunata) Small order of monocyclic crinoids (i.e. crinoids in which there is only one circlet of plates beneath the radial plates which bear the arms) with well-developed pentamerous symmetry. Some authorities would raise this group to subclass rank because of the 10 unique, sausage-shaped plates covering the ambulacra, and the incorporation of the lowest circlet of arm plates into the top of the cup. They range from Middle Ordovician to Upper Silurian in age.

Coronatida (subclass Scyphomedusae) Order of free medusae, distinguished by a circular, horizontal, coronal groove. They are found mostly in the deeper parts of the ocean; surface forms are also known in warmer water.

coronaviruses (Coronaviridae) Group (family) of RNA-containing viruses in which the individual virions are roughly spherical and bear peripheral projections, giving them a crown-like appearance in electron microscopy. They are found in birds and mammals, and can cause disease of the respiratory tract (including the common cold).

Coronella austriaca (smooth snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snake which rarely exceeds 70 cm in length. It is brown, reddish, or grey, with two rows of indistinct dorsal spots. Its diet comprises mainly lizards and small mammals. It is ovoviviparous (2–15 young). It inhabits Europe and W. Asia. In Britain it is limited to southern heathlands and is legally protected.

corpora allata *See* corpus allatum.

corpora quadrigemina In the midbrain of mammals, two pairs of lobes extending from the dorsal surface, the anterior pair being optic centres and the posterior pair auditory centres.

corpora trapezioidea Band of nerve fibres connecting the right and left sides of the cerebellum.

corpus allatum One of the glandular organs found on either side of the oesophagus in most insects, although they may become fused to form a single organ, as in Diptera. The corpora allata, which release juvenile hormone, have a nervous connection with the corpus cardiacum, which in turn connects with neurosecretory cells in the brain.

corpus callosum In Eutheria, a band of nerve fibres connecting the left and right cerebral hemispheres (cerebrum).

corpus luteum Mass of yellow tissue left after ovulation when a mature Graafian follicle ruptures from the ovary of a mammal. It is formed by

ingrowth of the follicle wall as a result of the action of luteinizing hormone (which in turn requires the presence of lactogenic hormone from the pituitary). If ovulation does not result in fertilization, then the corpus luteum quickly degenerates. If fertilization occurs, then the corpus luteum persists and continues to secrete luteal tissue during part or all of pregnancy.

correlated response Response in the form of a change in a character which occurs as an incidental consequence of the selection for an apparently independent character, e.g. selection for increased bristle number in *Drosophilia* may also result in reduced fertility.

correlation 1 (geol.) In stratigraphy, correlation depends on the similarities that exist in terms of lithology or fossil content. Thus isolated stratigraphic units, or successions, may be 'correlated', or equated in terms of time. 2 (statistics) Correlation is a technique used to determine the degree of association between two data sets.

corridor dispersal route As originally defined by the American palaeontologist G. G. Simpson (1940), a corridor is a migration route that allows more or less uninhibited faunal interchange. Thus many or most of the animals of one faunal region can migrate to another one. A dispersal corridor has long existed between W. Europe and China via Asia.

corrie *See* cirque.

cortex An outer layer. In plants, tissue immediately below the epidermis. In vertebrates, the cerebral cortex is a layer of grey matter lying above each cerebral hemisphere in the brain.

corticolous Growing on or in tree bark.

cortina Mesh of fine, web-like fibres extending from the edge of the pileus to the stipe in the fruit bodies of certain agarics.

Cortinariaceae (order Agaricales) Family of fungi in which the spores in masses appear brownish or rust-coloured. In the fruit body, the stipe (when present) and pileus are confluent. There are many genera, found mainly on soil, and particularly in woods, where many species form mycorrhizal associations with trees.

Cortinarius (family Cortinariaceae) Very large genus of fungi in which the mushroom-like fruit bodies have a cortina when young. The gills are rust-brown at maturity, and the spore print is rust-brown. *Cortinarius* are found on the ground in woodland, where they often form mycorrhizal associations with trees. The numerous species are not easy to distinguish from each other in the field.

cortisone Steroid hormone produced by the adrenal cortex and used medicinally to suppress allergies and other manifestations of the immune response.

corundum Mineral, specific gravity 3.9–4.1, hardness 9.0, chemical composition Al_2O_3, whose name is derived from the Sanskrit word for 'ruby'. It occurs in nephaline-syenites and metamorphic rocks, e.g. marble, gneiss, and schists; and also in alluvials because of its hardness. It is associated with muscovite, haematite, and rutile, and is distinguished by its hardness, specific gravity, and crystal form. The two main varieties are blue and green, but corundum can be yellow, or brown to almost black and transparent, flawless crystals are the gemstones blue sapphire, red ruby, and green oriental emerald. It has an adamantine to vitreous lustre. It crystallizes in the trigonal system. The crystals are usually rough and barrel-shaped, tapering, and also flat and tabular. The main use of corundum is based on its hardness. It is made into grinding wheels and discs, emery paper, and powders for grinding and polishing.

Corvidae (crows, jays, magpies; order Passeriformes) Family of small to large black, black and white, or brightly-coloured birds, with large heavy bills and round nostrils, covered by feathers. Some are crested, some are long-tailed. All have strong legs. Corvidae are typically gregarious, and inhabit forest, woodland, and open country. They are omnivorous, and their nests are usually open and bulky, in a tree or on a cliff. Many species are kept as cage birds and are good vocal mimics. There are 26 genera, with about 110 species, found worldwide, except for New Zealand and Pacific Ocean islands.

Corvus (crows, ravens; family Corvidae) Genus of typical crows, mainly black, black and white, or black and grey, with large bills (especially the ravens). *C. frugilegus* (rook) has bare white skin on its face. They are strong fliers, and inhabit forests, woodland, and open country, some being partially predatory. Nests are typically bulky, in trees and on ledges. There are 40 species, found worldwide, except for S. America, New Zealand, and Pacific Ocean islands.

Corvus frugilegus (rook) *See Corvus*.

Corydalidae (Dobson flies, fishflies; subclass Pterygota, order Megaloptera) Family of large, soft-bodied insects which have a fluttering flight pattern and are often found near streams. Adults possess ocelli, and the larvae, which are found in streams and under stones, have a pair of hooked anal prolegs, but lack a terminal filament. Male Dobson flies of the genus *Corydalus* have mandibles three times the length of the head. Dobson fly larvae (hellgrammites) are used as fish bait.

Corydalus (Dobson fly) *See* Corydalidae; and Megaloptera.

Corydorus aeneus (bronze catfish) *See* Callichthyidae.

Corydorus bastatus (pygmy catfish) *See* Callichthyidae.

Corylus (family Betulaceae) Genus of small trees or shrubs, which often reproduce by suckering. *C. avellana*, *C. maxima*, and others have edible nuts (subtended by leafy bracteoles), the hazel, filbert, and cobnut. Formerly they were coppiced to provide brushwood for fuel and light constructions. There are 15 species, which occur in northern temperate forests.

corymb Racemose inflorescence in which the lower pedicels are longer than the upper so that the flowers lie as a dome, or dish, and the outline is roundish or flattish.

Corynebacterium Genus of Gram-positive bacteria, of uncertain taxonomic position, in which the cells tend to be irregular in shape, but are usually straight or slightly curved rods. They are chemo-organotrophic, and are found in a wide range of habitats. Some are pathogenic in animals (e.g. *C. diphtheriae* can cause diphtheria), while others are pathogenic in plants.

coryneform Applied to the club-shaped and pleomorphic cells of *Corynebacterium* species and similar bacteria.

Corypha (family Palmae) Genus of giant fan palms which are among the most massive of all palms. The stem is solitary, forming a gigantic, terminal, tree-like inflorescence, and then dying. The flowers are bisexual. The petals are free, and the ovary trilocular: only one locule develops to fruit. The stem has a reddish sago. The leaf sheaths yield useful fibre, and the blades are used for writing material. The endosperm is a vegetable ivory. *C. umbraculifera* (talipot palm), is the most massive species. There are eight species, found from India to N. Australia in seasonally dry climates.

Coryphaenidae (dolphinfish, dorado; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine oceanic fish which are highly rated as sport fish. Dolphinfish have a high forehead (almost vertical in males) and a strongly tapering body ending in a forked tail-fin. They are very fast swimmers, capable of reaching speeds of more than 60 km/h. They are well known for their fighting ability once hooked, as well as for the spectacular colour changes noticed by the fishermen. Feeding mainly on flying fish and squid, the larger male dolphinfish can grow to more than 1.5 m in length. There are only two species, with a worldwide distribution.

Coryphaenoides rupestris (European grenadier) *See* Macrouridae.

cosmine Type of dentine perforated by branching canals.

cosmoid scale Type of scale found only in fossil lungfish (Dipneusti), and in Crossopterygii, including the living coelacanth. The thick scales are composed of layers of vitrodentine, followed by cosmine, and finally by layers of vascular and laminated bone underneath.

cosmopolitan distribution Distribution of an organism that is worldwide or panendemic. Apart from weeds, commensal animals, and some of the lower groups of cryptogams, there are relatively few organisms that occur on all six of the widely-inhabited continents.

cosmopolitan flying fish (*Exoceutus volitans*) *See* Exoceutidae.

Cossidae (goat moths, carpenter moths; order Lepidoptera) Family of small to very large moths in which the mouthparts are much reduced, the antennae are often bipectinate, and the medial vein is forked in the discal cell of both wings. A single female may lay many eggs. The larvae generally bore into trees, and pupation occurs in the tunnel. The family has a widespread distribution and many species are found in Australia.

Cossus cossus (goat moth; order Lepidoptera, family Cossidae) Species of moth whose larva smells like a goat and bores into trees, particularly willow, elm, and ash. The larva takes 3–4 years to mature. The species is found in Europe (including Britain), N. Africa, and C. and W. Asia. It is the largest British cossid.

costa One of the main longitudinal veins, which generally forms the leading edge of an insect wing.

costal respiration *See* buccal force pump.

Costus (family Zingiberaceae) Genus of plants, which are distinctive among the gingers for their spiralling stems with spirally-borne leaves. The inflorescence is a terminal head. There are 150 species, with a pantropical distribution.

cotidal line Line joining points at which given tidal levels (such as mean high water or mean low water) occur simultaneously. The lines are shown on certain hydrographic charts. The same information is contained in tide tables, where the data is given as differences from the times of high or low water at a 'standard port'.

cotingas *See* Cotingidae.

Cotingidae (cotingas; order Passeriformes) Family of small to large, brightly coloured birds, many having facial wattles, crests, and modified wing feathers. They are arboreal, feeding on insects and fruit, which are taken mainly in flight. They usually nest in trees and bushes, building an open cup; but *Rupicola* (cock-of-the-rock) builds a mud-and-vegetable nest on rock faces. There are 25 genera, with 65 species, found in C. and S. America.

Cotinus (family Anacardiaceae) Genus of shrubs whose resin is mildly irritant. *C. coggygria*, found from the Mediterranean region to China, is the smoke bush or wig tree, and is much cultivated. There are three species, occurring in warm-temperate regions.

Cotoneaster (family Rosaceae) Genus of trees and low shrubs which resemble *Crataegus* but are not thorny: members of the genus have entire leaves, and carpels that are free from each other on the inner sides, with stony walls. The fruit has a mealy, fleshy case formed from the receptacle cup. Several species are grown in gardens. There are about 50 species, with a palaearctic and temperate distribution.

Cottidae (sculpin, father lasher; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Very large family of marine and freshwater fish, all of which have a bony support beneath the eye, and the eyes placed high on the head. There is a deep notch between the two dorsal fins, and the large pectorals are wing-like. Most sculpins are found in inshore waters. *Myoxocephalus scorpius* (North Atlantic father lasher), 60 cm long, is a voracious

predator, but is used as a source of bait and fishmeal. Some species, e.g. *Gymnocanthus tricuspis* (staghorn sculpin), live in cold polar waters. There are about 300 species, widespread in non-tropical regions. *See also* Psychrolutidae.

Cottocomephoridae (Baikal sculpins; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of sculpin-like freshwater fish with large eyes, and very large pectoral fins. They are found in the Lake Baikal drainage system (USSR).

cotton *See* Malvaceae.

cotton boll weevil (*Anthonomus grandis*) *See* Curculionidae.

cotton stainer *See* Pyrrhocoridae.

cotton-tail Common name for several species of N. American lagomorphs of the genus *Sylvilagus*. *See also* Leporidae.

cottonwood *See Populus*.

Cottunculidae (class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of marine, sculpin-like fish with a rough skin and continuous dorsal fin. There are about six species, occurring in temperate to cold waters.

cotyledon Seed leaf which is borne on a plant embryo. Characteristically there is one leaf in the Monocotyledoneae, and two leaves in the Dicotyledoneae, but there are exceptions, especially in the latter group.

Cotylosauria Anapsid stem reptiles which appeared in the Carboniferous, having diverged from labyrinthodont amphibians. They flourished in the remainder of the Palaeozoic, but rapidly dwindled to extinction in the Triassic.

couas *See* Cuculidae.

coucals *See Centropus*; and Cuculidae.

cougar (*Puma concolor*) *See Puma*.

Coula edulis (African walnut) *See* Olacaceae.

coupe Area that is to be cut in a particular year of a coppice rotation. *See also* cant; and hag.

coural *See* Leptosomatidae.

coursers *See Cursorius*; and Glareolidae.

courtship (ethol.) All the behaviour that precedes and is associated with the sexual act.

Couvinian *See* Devonian; and Givetian.

covalent bond Bond in which a pair (or pairs) of electrons is shared between two atoms. The bond is often represented by drawing a single line between the symbols of the two atoms that have bonded together. Sometimes the bonding is between atoms of different elements (e.g. hydrogen chloride, H–Cl), and sometimes between atoms of the same element (fluorine, F–F). The name 'molecule' is used to describe any uncharged particle containing covalently bonded atoms.

cover In descriptions of plant communities, the proportion of ground, usually expressed as a percentage, that is occupied by the perpendicular projection down on to it of the aerial parts of individuals of the species under consideration. The most widely used visual scales are the Domin scale and the Braun-Blanquet five-point scale. A more objective estimate may be obtained using a pin-frame or point-quadrat.

cover–abundance measure A linked scheme for estimating cover visually. It is based on percentages at the top end, but uses abundance estimates for species with low cover values. The most widely known is the Domin scale.

covered smut Disease of cereals caused by smut fungi (order Ustilaginales), e.g. *Tilletia caries*. The fungal spore masses are enclosed within the glumes of the cereal and are not released until threshing.

cover–sociability scale Method for recording vegetation, devised by Braun-Blanquet, in which two scales are combined. The first describes the number and cover of a species, ranging from presence through five scales of cover; the second indicates the spatial arrangement of the individuals concerned, e.g. as 'isolated' or 'clumped'.

covert 1 Shelter for wildlife, especially a thicket that hides game. 2 *See* wing covert.

covirus Type of virus in which there are two or more different types of virion, each containing a different portion of the genome. Both or all types of virion must be present in the same host for replication of the complete virus to occur.

cowbirds *See* Icteridae; and *Molothrus*.

cowfish *See* Ostraciontidae.

cow killer *See Dasymutilla occidentalis*.

Cowper's gland Small gland that discharges a mucus, possibly serving as a lubricant, into the male urethra.

cowpox Disease which primarily affects cattle, although it may be transmitted to human handlers. Papules, which develop into vesicles, appear on the teats and udders of cows. The disease is caused by a poxvirus.

cow shark *See* Hexanchidae.

cow's tail pines *See* Cephalotaxaceae.

cow-tree (milk tree, *Brosimum galactodendron*) *See Brosimum*.

coxa Uppermost joint of the leg of an insect, which articulates with the thorax proximally, and with the trochanter distally. The coxa is usually a stout, truncated cone of cuticle, freely mobile with respect to the thorax; in Lepidoptera, though, the middle and hind coxae are fused to the thorax. Muscles that move the coxae originate in the thorax.

coxal gland In some arthropods, an excretory gland opening at the base of the legs.

coxal vesicle In some uniramous arthropods, an eversible sac associated with the style or the basal segment of the legs.

Coxiella (family Rickettsiaceae) Genus of bacteria which are parasitic inside the cells of vertebrate or arthropod hosts. The cells are short rods. There is one species, *C. burnetii*. This is the causal agent of

Q fever in humans. The organism is resistant to adverse environmental conditions, e.g. high temperatures and desiccation, and can often survive pasteurization.

coxopodite In some Crustacea, the basal segment of the biramous abdominal limb.

coxsackievirus Virus, belonging to the Picornaviridae, named after the town Coxsackie in New York State where the virus was first isolated. It can infect a range of animals, including humans, and may cause a variety of diseases, but often the symptoms are mild or non-existent.

coyote (*Canis latrans*) *See* Canidae.

coypu (*Myocaster coypu*) *See* Capromyidae.

crab apple *See Malus*.

crab-eating fox (*Cerdocyon thous*) *See* Canidae.

crab louse *See Pthirus pubis*.

crab plover (*Dromas ardeola*) *See* Dromadidae.

Crabro *See* Sphecidae.

crabs **1** *See* Crustacea; Decapoda; and Cancridae. **2** (edible crab) *See Cancer pagurus*. **3** (giant spider crab) *See Macrocheira kaempferi*. **4** (green crab) *See Carcinus maenas*. **5** (hermit crabs) *See* Paguridae; and *Pagurus bernhardei*. **6** (Japanese island crab) *See Macrocheira kaempferi*. **7** (land crabs) *See Cardiosoma guanhumi*; and Gecarcinidae. **8** (mud crabs) *See Pseudocarcinus gigas*; and Xanthidae. **9** (shore crab) *See Carcinus maenas*. **10** (spider crabs) *See* Majidae. **11** (spiny spider crab) *See Maja squinado*. **12** (stone crab, *Menippe mercenaria*) *See* Xanthidae. **13** (swimming crabs) *See* Portunidae.

crab spiders *See* Thomisidae.

crachin Condensation as low cloud or fog, often with drizzle, which is frequent in spring on coastal areas of the Gulf of Tonkin and S. China. The weather results from advection of warm air over a cold surface, or by mixing of air masses at the surface.

Cracidae (curassows, guans, chachalacas; order Galliformes) Family of black, black and white, or brown, long-tailed, pheasant-like birds with short, rounded wings, and strong legs with large feet. Their bills are variable, often having an ornate knob or wattle, and many have crests and bare throat skin which is coloured and pendulous. They are mainly arboreal, feeding on fruit and leaves, and nesting in trees. There are eight genera, with 41 species, found in southern USA, and in C. and S. America. Many species are endangered.

Cracticidae (butcherbirds, currawongs; order Passeriformes) Family of medium-sized, grey and white birds, with stout, sometimes hooked, bills, and short, pointed wings. They are gregarious and arboreal, feeding on large insects, small vertebrates, and fruit, taken on the ground. They build an open nest in a tree. There are three genera, with 10 species, found in Australia and Papua New Guinea.

crag and tail Landform consisting of a small rocky hill (crag) from which extends a tapering ridge of unconsolidated debris (tail). The crag is a residual feature left by selective glacial erosion, while the tail is drift-deposited by ice on the lee side of the obstacle.

crakes *See Porzana*.

cranberry *See Vaccinium*.

craneflies *See* Tipulidae.

cranes *See* Gruidae; and *Grus*.

Craniacea (suborder Craniidina) Superfamily of inarticulate brachiopods which first appeared in the Lower Ordovician and which contains the living cosmopolitan genus *Crania*.

Craniata The groups of animals in possession of a bony or cartilaginous skull and a dorsal vertebral column. *See also* Vertebrata.

Craniidina (order Acrotetrida) Suborder of inarticulate brachiopods with strongly punctate, calcareous shells. Some are free-living, but many are attached by cementation of all or part of their pedicle valve. There is no pedicle. Growth is holoperipheral in both valves. They are first known definitely from Lower Ordovician rocks. The suborder consists of one superfamily, two families, and 12 genera.

Cranoglanididae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Small family of freshwater catfish with a scale-less body, four pairs of barbels, a short dorsal fin, and a forked tail-fin. They are found in Asia.

Craseonycteridae (order Chiroptera, suborder Microchiroptera) Family of very small, tail-less bats, with long, separate ears in which the tragus is tapered and visible; a simple nose with a narial pad and open, non-valvular nostrils; and the second digit of the forelimb partly free in the leading edge of the wing. They were discovered in 1973, only in Thailand. There is one species, *Craseonycteris thonglongyai* (Kitti's bat), which is the smallest living mammal.

Craspedia (family Compositae, tribe Inuleae) Genus of annual and perennial herbs, mainly with radical leaves and yellow flowers held in dense globular heads at the end of a long stalk. There are few species. Three are endemic to arid regions of Australia, and one is cosmopolitan in Australia and New Zealand.

Crassulaceae Family of usually succulent herbs, or low shrubs related to the Rosaceae. The flowers are regular, and usually pentamerous, with the stamens alternating with the petals or twice their number. The carpels are usually free, forming follicles (or a capsule) in the fruit. They show unusual (crassulacean) respiratory metabolism. Many are cultivated, especially *Sedum* and *Sempervivum* species (stonecrops, house leeks). There are 30 genera, with about 1300 species. Most occur in dry, warm, temperate regions, but they are cosmopolitan.

crassulacean acid metabolism Method of carbon-dioxide fixation that conserves water in members of the Crassulaceae and certain other succulent, drought-resisting plants. At night, when the

external temperature is low enough for stomata to be open, carbon dioxide enters them and is incorporated into organic acids. In the day, when the stomata remain closed so as to conserve water, these acids are decarboxylated and the carbon dioxide is used for photosynthesis in the Calvin cycle.

crater 1 General term for a relatively small, funnel-shaped depression produced by vulcanicity, from which gases, tephra, and lava are or have been ejected. Several types are recognized: a summit crater on a cone of pyroclastics marks the site of ejection; a maar, often occupied by a lake, results from explosive activity; a lava sink is a vent enlarged from collapse and from which lava is emitted; and a caldera is a large volcanic depression. 2 Near-circular depression produced by the impact of an extraterrestrial body, e.g. Meteor Crater, Arizona. Meteorite craters are formed by the explosion outward and upward of material compressed and heated strongly by the energy of impact, and so usually are circular at the time they form.

Craterellus (subclass Holobasidiomycetidae) Genus of fungi in which the hymenium is borne on the smooth or wrinkled lower surface of the fruit body. In most species the fruit body is dark-coloured. They are found on the ground under trees. *See also* horn of plenty.

craton (shield) Area of the Earth's crust, invariably part of a continent, which is no longer affected by orogenic activity. This stability has existed for approximately 1000 million years. A classic example is the Canadian Shield.

Cratoxylum (family Guttiferae or Hypericaceae) Genus of medium-sized trees which produce a light, general-purpose timber. The fruit is a capsule, the seeds are winged. There are six species, occurring in tropical SE Asia.

Crax (curassows; family Cracidae) Genus of large, mainly black birds with ornate, coloured bills, or crests of decurved feathers. *C. blumenbachii* (red-billed curassow) from SE Brazil is highly endangered. There are 12 species, found in C. and S. America.

Crax blumenbachii (red-billed curassow) *See Crax*.

crayfish *See* Decapoda.

Creadion *See* Callaeidae.

creatine phosphate High-energy phosphorylated, nitrogenous compound that acts as an energy store in muscles and helps to maintain a relatively constant level of ATP in the muscle during contraction:

$$\text{Creatine phosphate} + \text{ADP} \overset{\text{creatine kinase}}{\leftrightarrow} \text{creatine} + \text{ATP}$$

Creediidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of slender-bodied, marine coastal fish with a protractile mouth; spineless, long dorsal and anal fins; and the lower jaw lined with skin tufts (cirri). There are about three species, found in S. Africa and Australia.

creep Slow movement of the regolith down hillslopes, which occurs as a result of the downslope bias due to gravity that takes place when any disturbance occurs in the regolith. Disturbance may be due to freezing and thawing; to expansion and contraction (resulting from temperature change or from wetting and drying); to additional weight and lubrication by water; or to the activities of burrowing animals.

Creightonella *See* leaf-cutter bee.

crenate With a round-toothed or scalloped edge or margin.

crenulate Finely notched.

crenulation cleavage *See* cleavage.

Creodonta (class Mammalia, subclass Theria, infraclass Eutheria, cohort Ferungulata, superorder Ferae) The more ancient of the two placental mammalian carnivorous orders, an extinct order comprising two families (Oxyaenidae and Hyaenodontidae), which appeared in the late Cretaceous and dwindled to extinction in the Pliocene. Oxyaenids were rather mustelid, although some of them were large; hyaenodonts had more narrow skulls, longer legs and well developed carnassials. They diversified into forms reminiscent of the dogs, cats, and hyenas of the order Carnivora. Only the hyaenodonts survived the Eocene, and filled the role of scavengers until they were displaced by the modern hyena. Creodonts were small-brained and slow-moving, and are not related closely to modern carnivores.

creodont-like teeth Teeth resembling those of the Creodonta, carnivorous mammals of the early Tertiary, in which carnassials were formed by the molars, rather than premolars and molars as in modern Carnivora.

creosote fungus *Cladosporium resinae*, a fungus which can grow in the presence of creosote.

Crepidotus (family Cortinariaceae) Genus of fungi in which the fruit body has no stipe, or a very short stipe on the under-side of the cap. The cap is typically kidney-shaped or shell-shaped; gills are white or pale at first, becoming coloured cinnamon or pinkish. They are found on wood, or on other plant debris.

crepuscular Of the twilight; the term is applied to animals that are active at dusk.

crepuscular rays Beams of sunlight made visible by haze in the atmosphere. Such effects are seen where rays penetrate gaps in clouds such as stratocumulus. This effect is called 'Jacob's ladder'. In other cases rays from a low sun diverge upwards above cumuliform cloud.

crescent perch (*Therapon jarbua*) *See* Theraponidae.

cress (*Lepidium sativum*) *See Lepidium*.

crested shelduck (*Tadorna cristata*) *See Tadorna*.

crestfish (*Lophotus capelei*) *See* Lophotidae.

Cretaceous Third of the three periods included in the Mesozoic Era. It began 135 million years ago and ended 65 million years ago. It is noted for the

deposition of the chalk of the White Cliffs of Dover, England, and for the mass extinction of many invertebrate and vertebrate stocks. Among these were the dinosaurs, mosasaurs, ichthyosaurs, and plesiosaurs.

Creutzfeldt–Jacob disease Slow virus disease involving degeneration of the central nervous system.

crevasse Deep fissure in the surface of a glacier, caused when tensile stress overcomes the shear strength of ice in the brittle upper few metres. Appropriate tensile stresses are typically developed when a glacier moves over a convex-up slope.

Crex (corncrake; family Rallidae) Slim, brown rail with short, stout, chestnut wings. It appears to be a weak flier, but is a long-distance migrant. It inhabits grassland, feeding on insects and worms, and nesting on the ground. Population is declining due to changes in agricultural practice. This monotypic genus is found in Europe, Africa, and Asia.

Cribellina (mudstars; subclass Asteroidea, order Paxillosida) Suborder of starfish that are characterized by the possession of specialized, dorsoventrally placed fascioles (cribiform organs) between some or all the marginal ossicles. The suborder is known from the Cretaceous to Recent.

cribellum Sieve-like structure which lies just anterior to the spinnerets of some spiders. In these, the cribellate spiders, there is also a row of small, curved bristles on the dorsal surface of the metatarsus of the fourth leg (the calamistrum). The calamistrum combs out the very fine strands of silk from the cribellum, to form the characteristically bluish silk of these species.

cribiform organs *See* Cribellina.

Cribrimorpha (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans in which the frontal (i.e. ventral) region of individuals is partially roofed by a network of fused, calcite spines, whose arrangement is important in classification. The division was abundant in the Cretaceous, when it appeared, and it continues to the present day.

Cricetidae (order Rodentia, suborder Myomorpha) Large and very successful family comprising the hamsters, voles, lemmings, gerbils, and the New World rats and mice. Most are terrestrial (and some of these are burrowing), but others are semi-aquatic. Their form varies according to their adaptation to a particular way of life. *Peromyscus leucopus* is the white-footed deer mouse of N. America, which bears a striking resemblance to the field mouse (*Apodemus sylvaticus*) of Europe, which belongs to the Muridae. The family also includes *Mesocricetus auratus* (golden hamster), and *Ondatra zibethicus* (musk rat or musquash). Their distribution is worldwide except for Australasia and Malaysia. There are about 97 genera, with some 567 species.

Cricetomys *See* Hemimeridae.

crickets *See* Ensifera; Gryllidae; Gryllotalpidae; Myrmecophilidae; Orthoptera; Prophalanopsidae; Rhaphidophoridae; Schizodactylidae; Stenopelmatidae; and Tridactylidae.

Cricoconarida (phylum Mollusca) Extinct and entirely Palaeozoic class of molluscs in which the shells are narrow, tapering cones composed of laminated calcium carbonate. Externally transverse rings, ripples, and striae generally occur, and longitudinal striations may also be present. The shell is composed of four parts: the embryonic chamber, the juvenile chamber, the adult chamber, and the apertural portions. The class contains two orders, and ranges in age from Lower Ordovician to Upper Devonian.

crimson-spotted rainbow fish (*Nematocentris fluviatalis*) *See* Melanotaeniidae.

Crinoidea (feather-stars, sea-lilies; subphylum Pelmatozoa) The most primitive living class of echinoderms, whose members have a long stalk (rarely sessile without a stalk, or free-swimming); a calyx (lower surface) composed of regularly arranged plates; well-developed, movable arms; mouth and arms on the upper surface; radial food-grooves on the arms, leading to the mouth; and tube-feet on the arms. The more primitive types are attached to the sea-floor by stalks, while the more highly evolved types are free-swimming. They are known with certainty, as eocrinoids, from the Lower Ordovician onwards, and were fully modern by the end of the Palaeozoic.

Crinozoa (phylum Echinodermata) Subphylum, also known as Pelmatozoa, whose members have radial symmetry, a tendency to produce a cup-shaped or globoid, plated test (theca), and appendages (brachioles or arms) which support exothecal extensions of feeding ambulacra. The subphylum includes eight classes, seven of which were extinct by the end of the Palaeozoic, with only the Crinoidea surviving to the present day.

Crinum (family Amaryllidaceae) Genus of large, bulbous plants with umbels of showy flowers. There are about 100 species, occurring in the tropics, especially on coasts.

criss-cross inheritance Transmission of a gene from mother to son or father to daughter; for example in X-chromosome linkage. Classical examples are wing colour in the magpie moth (*Abraxus*), and feather pattern (barred v. non-barred) in chickens.

crista (pl. cristae) Infolding of the inner membrane of a mitochondrion that projects into the matrix of the organelle. Cristae bear numerous mushroom-shaped bodies, variously called respiratory assemblies, stalk bodies, or elementary particles, which contain certain of the enzymes involved in ATP synthesis.

Cristispira (family Spirochaetaceae, order Spirochaetales) Genus of spirally-shaped bacteria in which the cells contain over 100 axial fibrils. They are found in a variety of marine and freshwater molluscs.

crochets *See* prolegs.

crocodile fish *See* Chanidae.

crocodile lizard (*Shinisaurus crocodilurus*) *See* Xenosauridae.

crocodiles 1 *See* crocodilians. 2 (true crocodiles) *See* Crocodylidae.

Crocodilia (class Reptilia) Order of the 'ruling reptiles' (Archosauria) which includes the crocodiles, alligators, caimans, and gavials (gharials). They are derived from thecodontian ancestors and are closely related to the dinosaurs and pterosaurs. They are first recorded from Triassic rocks and were the only archosaurs to survive the Mesozoic Era, although strictly speaking the birds (Aves) are also archosaurs. Modern crocodilians are large, tropical, aquatic reptiles. The snout is long with strong conical teeth, raised valvular nostrils, and a secondary palate (which allows air-breathing with the mouth open in the water). The body has an armoured skin, short, powerful limbs, and a laterally-flattened tail with a double row of raised scales merging towards the tip.

crocodilians *See* Crocodilia.

Crocodylidae (true crocodiles, dwarf crocodiles, false gharial; order Crocodilia) Crocodilian family in which the fourth tooth of the lower jaw fits into a notch in the upper jaw, being visible when the mouth is closed. There are 13 species, occurring in fresh, brackish, and salt water in the Old and New World tropics. *See also Crocodylus niloticus*; and *Crocodylus porosus*.

Crocodylus niloticus (Nile crocodile; order Crocodilia, family Crocodylidae) Species of large crocodiles, with recorded lengths of over 6 m, from C. and S. Africa, and Madagascar, which due to hunting are now rare over much of their range. They bask on river banks and may pull their legs to beneath their bodies in order to move rapidly on land.

Crocodylus porosus (salt-water crocodile, estuarine crocodile; order Crocodilia, family Crocodylidae) Species of crocodiles which are found in estuaries and swimming in the open sea. Lengths of over 6 m have been recorded. They are distinguished by ridges from the eyes along the length of the snout. Salt-secreting glands are developed around the eye. They range from India to N. Australia.

Crocosmia (*Tritonia*, montbretia; family Iridaceae) Genus of plants with corms and two-ranked, narrow leaves flattened in one plane, as in irises. There are about five species, occurring in S. Africa.

Crocus (family Iridaceae) Genus of about 70 species of plants in which tufts of narrow leaves arise from corms, and have white midribs. The flowers are solitary, subsessile on the corms and regular; and have six similar perianth segments, and an extremely long perianth tube resembling a flower-stalk. There are three stamens on the tube. The ovary is three-celled and inferior, forming a capsule lifted up on a stalk in the fruit. Many species are cultivated for their beauty. Saffron is produced from the style branches of *C. sativus*. There are about 70 species, occurring in the temperate Old World, especially in the Mediterranean region.

crop 1 Produce from the land. 2 Thin-walled extension of the oesophagus of a bird, used for food storage. It is particularly well developed in grain-eating birds.

cross-agglutination test One of a series of tests commonly used in blood typing, in which erythrocytes from a donor of unknown type are mixed with sera of known types.

cross-bedding *See* bedding.

crossbills *See* Fringillidae; and *Loxia*.

cross-breeding Usually, outbreeding or the breeding of genetically unrelated individuals. In plants this may entail the transfer of pollen from one individual to the stigma of another of different genotype. In animals it refers to the mating of individuals that are not consanguineous.

cross-dating The matching of tree-ring width patterns and other properties among the trees and fragments of wood from a particular area. This enables the year in which each ring was formed in living trees and recent stumps to be determined accurately, the presence of false rings or the absence of rings in individual specimens being made apparent. By matching ring series from living specimens with those from older (e.g. constructional) timbers, the chronology may be extended backwards.

crossing-over Exchange of genetic material between homologous chromosomes by breakage and reunion. This occurs during pairing of chromosomes at meiosis, and in some organisms (for example certain fungi, and insects such as *Drosophila*) may also occur at mitosis. The temporary joins between chromosomes during crossing-over are called chiasmata.

Crossopterygii (class Osteichthyes) Subclass of bony fish including both fossil and living lobe-finned or tassel-finned fish, including the Coelacanthini and Rhipidistia. The former are well known from Palaeozoic and Mesozoic rocks, but were thought to have become extinct by the end of the Cretaceous until living specimens were netted this century in the Indian Ocean. The Rhipidistia did become extinct, although not before they gave rise, in the Devonian, to the amphibians. They are characterized by the fact that all fins (except the tail-fin) are based on movable stalks or lobes. The tail-fin is either heterocercal or diphycercal. *Compare* Coelacanthiformes.

cross-over region The segment of a chromosome lying between any two particular genes used as markers, for example during gene mapping by recombination experiments.

cross-pollination Transfer of pollen from the stamen of a flower to the stigma of a flower of different genotype but usually of the same species. *See also* cross-breeding.

crossthroat sawplate (*Serrivomer jesperseni*) *See* Serrivomeridae.

Crotalidae (pit vipers; order Squamata, suborder Serpentes (Ophidia)) Family of snakes which are closely related to true vipers, but which have

heat-sensitive pit organs just behind the nostrils. Their diet consists mainly of birds and small mammals. Tail-rattling mechanisms have been developed in advanced forms (rattlesnakes). There are approximately 130 species, occurring in the Americas and tropical Asia. *See also Crotalus cerastes*; and *Crotalus horridus*.

Crotalus cerastes (sidewinder; order Squamata, suborder Serpentes (Ophidia), family Crotalidae) Species of small (up to 60 cm long) desert rattlesnakes from the SW USA. They are stout-bodied, with a small horn above each eye. The common name refers to their mode of locomotion over loose sand. As the body is thrown into loops the snake proceeds diagonally. 'Sidewinding' also occurs in some vipers (Viperidae).

Crotalus horridus (timber rattlesnake; order Squamata, suborder Serpentes (Ophidia), family Crotalidae) Species of heavy-bodied, venomous snakes with a rattle at the end of the tail, formed from loosely connected horny segments that are added at each moult. They grow up to 1.8 m long, and feed on small mammals. They occur in woodland in the eastern USA.

Croton (family Euphorbiaceae) Genus of small trees and shrubs, commonly with stellate hairs, producing a fruit which is a capsule. Several are medicinal, and croton oil from *C. tiglium* is a powerful purgative. There are 150 species, occurring throughout the tropics and subtropics.

croton (*Codiaeum variegatum*) *See Codiaeum*.

croton oil *See Croton*.

Crotophaga (anis) *See* Cuculidae.

crotovina *See* krotovina.

crowberry (*Empetrum*) *See* Empetraceae.

crow butterflies *See* Danainae.

crown gall Common and widespread plant disease which can affect a very wide range of woody and herbaceous plants. The disease is caused by the bacterium *Agrobacterium tumefaciens*. Galls are formed on roots, stems, or branches of infected plants. On herbaceous plants the galls are usually soft, while on woody plants they tend to be hard. On trees, crown galls may reach sizes of one metre or more across.

crows *See* Corvidae; and *Corvus*.

Cruciferae Family of mostly annual or perennial herbs with alternate leaves, and racemes of four-sepalled, four-petalled flowers, the petals being arranged in a cross. There are usually two outer stamens plus four larger, inner ones. The ovary consists of two carpels, but produces dry fruits of various forms, either capsules or indehiscent. Crucifers provide many valuable vegetables (*Brassica oleracea*, cabbage, etc.) and are sources of useful oils. No members of the family are poisonous. There are 220 genera, with nearly 2000 species, mainly northern temperate, but cosmopolitan. *See also Brassica*.

crumb structure Type of soil structure in which the structural units or peds have a spheroidal or crumb shape. Crumb structure is often found in more porous than granular organo-mineral surface soil horizons, and provides optimal pore space for soil fertility.

crura *See* crus.

crura cerebri Band of nerve fibres, one on each side of the brain, connecting the cerebrum and the cerebellum.

crus (pl. crura) Part of the calcified brachial support in brachiopods which attach it to the interior beak region of the brachial valve.

crust 1 (geol.) The thin outermost solid layer of the Earth. It represents less than 1% of the Earth's volume, and varies in thickness from 5 km beneath the oceans to 60 km beneath mountain chains. 2 (pedol.) Surface layer, sometimes slightly cemented with calcium carbonate, silica, or iron oxide, which may be from a few millimetres to many centimetres in thickness but which is always harder and more compact than the soil below. Crusts are now being produced by mechanical action or pedogenesis, mainly in arid environments; less commonly they are relict or fossil features exhumed on the soil surface.

Crustacea (crabs, lobsters, shrimps, slaters, woodlice, barnacles; superphylum Arthropoda, grade Mandibulata) Diverse phylum of mandibulate arthropods with two pairs of antennae, one pair of mandibles, and two pairs of maxillae. The limbs are biramous, and are adapted for a wide range of functions. Closely placed setae on the limbs function as filters in filter-feeding species. Respiratory gills are situated on the appendages, but vary greatly in location and number; they are absent only in very small marine or aquatic species. In addition to the antennae, sense organs include a pair of compound eyes, and a small, dorsal, median, nauplius eye, comprising three or four closely applied ocelli. The nauplius eye, characteristic of crustacean larvae, is absent in many adults; and some groups lack the compound eyes. Nitrogenous excretion is via a pair of sacs opening into the bases of the second antennae (antennal glands) and/or the second pair of maxillae (maxillary glands). Most of the 31 400 species are marine, but there are many freshwater, species, and a relatively small number have invaded the land. A few marine species are parasites of other Crustacea; and one group, the Cyamidae, are ectoparasites of whales (whale lice). The first representatives of the group are known from Cambrian rocks.

crustaceous *See* crustose.

crustose (crustaceous) Crust-like in appearance, usually used of certain types of lichen thallus.

cryic *See* pergelic.

cryolite Mineral, specific gravity 3.0, hardness 2.5, chemical composition Na_2AlF_2, whose name is derived from Greek and means 'ice-stone'. It occurs in pegmatites that have been enriched with fluorine, and in association with siderite, quartz, galena, chalcopyrite, fluorite, and cassiterite. Its diagnostic features are its pseudo-cubic form, greasy lustre, and low refractive index. The powder becomes

almost invisible in water. It is colourless to white, sometimes brown to reddish; and has a white streak and a vitreous to greasy lustre. It crystallizes in the monoclinic system. Crystals are rare, but they are cubic-like and hexahedral, and also massive. It is used as a flux in the production of aluminium and enamels.

cryophilic Preferring to grow at low temperatures.

cryoplanation The reduction of relief to a gently undulating land surface under periglacial conditions. Equivalent to altiplanation.

cryoturbation General term for the disturbance of ground due to freezing and thawing. *See also* frost heaving.

crypsis Coloration that makes animals difficult to distinguish against their background, so tending to reduce predation.

Cryptacanthodes maculatus (Atlantic wrymouth) *See* Cryptacanthodidae.

Cryptacanthodidae (wrymouth; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of coastal marine fish with elongate bodies, long dorsal and anal fins, oblique mouth, and without pelvic fins. *Cryptacanthodes maculatus* (Atlantic wrymouth), 1 m long, often hides in burrows beneath the surface of the sea-bottom. These fish are found in temperate waters of the Atlantic and Pacific.

Cryptandra (family Rhamnaceae) Genus of bushy shrubs with small, sharp leaves and small, bell-shaped flowers which are white or pale pink. There are 40 species, endemic to temperate regions of Australia.

Crypteroniaceae Family of trees in which the leaves are simple, opposite, and without stipules. The flowers are tetra- or pentamerous. The fruit is a capsule. The family is related to Lythraceae. There are two genera, and five species, occurring from Assam to Malesia.

cryptobiosis Dormancy, used for example in relation to microbial spores that may show no signs of life for extended periods of time.

Cryptobranchidae (giant salamanders; class Amphibia, order Urodela (Caudata)) Family of what are probably neotenous, hynobiid descendants. Metamorphosis is incomplete; the gills are degenerate (hence the name, meaning 'hidden gills'), the eyelids never develop, and larval teeth are retained throughout life. The head and body are broad and flattened, the tail laterally compressed, the skin smooth and slimy, and the habit totally aquatic. The largest are more than 1.5 m long. Tertiary fossil species are distributed widely in the northern hemisphere, but there are only two living genera, comprising three species, in N. America and Asia.

Cryptocercidae (wood-eating cockroach; class Insecta, order Blattodea) Monotypic family comprising the semi-social *Cryptocercus punctatus* (wood-eating cockroach), an insect which is 2–3 cm long, and is notable for feeding on rotting wood. It shows remarkable similarities to the Isoptera (termites), and both share a similar gut fauna of protozoans that break down cellulose. The wood-eating cockroach occurs in N. America and E. Asia.

Cryptocercus punctatus (wood-eating cockroach) *See* Cryptocercidae.

Cryptococcaceae (class Blastomycetes) Family of imperfect fungi which do not form ballistospores. The vegetative stage may be unicellular and yeast-like, or some kind of mycelium may be formed. There are many genera. They are saprotrophic on fruit, bark, etc. or parasitic on skin and other tissue in humans and other animals.

Cryptococcus (family Cryptococcaceae) Genus of imperfect yeasts in which no mycelium is ever formed. There are many species, found in a wide range of habitats. *C. neoformans* can cause disease in humans.

Cryptodira (hidden-necked turtles; order Chelonia (Testudines)) Suborder of chelonians which withdraw the head straight back into the shell by flexing the neck vertically. There are 10 families, including marine, freshwater and terrestrial forms, and they are cosmopolitan, except for Australia.

Cryptodonta (phylum Mollusca, class Pelecypoda) Subclass of pelecypods most of which have thin, equivalve shells composed of aragonite. They have an amphidetic to opisthodetic external ligament. The hinge plate is narrow or absent, with most forms having an edentulous hinge margin; some members are taxodont. They have an infaunal mode of life. They first appeared in the Ordovician.

cryptogam Plant that reproduces by spores or gametes rather than seeds, i.e. an alga, fungus, bryophyte, or pteridophyte.

Cryptogramma (family Adiantaceae) Genus of ferns in which the fertile and sterile fronds are different but both have two or more pinnae. Sori are borne on the tips of veins below, protected by the reflexed leaf margin, and merging when mature into a continuous band. There are seven species native to the temperate northern hemisphere, S. America, and S. Africa, most occurring on mountain rock screes.

Cryptomeria (family Taxodiaceae) Genus of conifers comprising one species, *C. japonica*, occurring in China and Japan. It is a tall tree, with long, pointed, curved, spirally-arranged leaves, and short, globose cones with several short, curved spines on each cone scale.

Cryptophyceae Small class of unicellular algae in which the cells are dorsoventrally flattened, and have two flagella of equal length. Most species are photosynthetic, but a few are colourless and heterotrophic. Sexual reproduction is unknown. They are found in freshwater and marine habitats.

cryptophyte One of Raunkiaer's life-form categories, being a plant in which the perennating bud lies below the ground or water surface. The groups geophytes, helophytes, and hydrophytes are distinguished by the environment in which the perennating bud is found, i.e. land, marsh, and water respectively. *Compare* hemicryptophyte; chamaeophyte; phanerophyte; and therophyte.

Cryptoprocta *See* Viverridae.

Cryptostomata (subphylum Ectoprocta, class Gymnolaemata) Order of bryozoans in which the colony has a well developed, calcite skeleton, and assumes a frond-like, reticulate form, or more rarely a branching habit. Individual tubes are relatively short, and the apertures or orifices are hidden in a short shaft. The order is Palaeozoic, extending from the Ordovician to Permian.

cryptozoa Macroscopic invertebrate animals which live between litter and the soil.

Crypturellus (tinamous; family Tinamidae) Genus of typically brown and grey birds. They are found in forests and scrub, feeding mainly on vegetable matter and some insects. The nest is a scrape in the ground, and some *Crypturellus* species breed throughout the year. There are 20 species, found in C. and S. America.

crystal An homogeneous, ordered solid, having naturally-formed plane faces and a limited chemical composition. Crystals have a definite geometric arrangement that reflects the arrangement of the atoms of which they are composed. *See* crystal symmetry.

crystalline Applied generally to metamorphic or igneous rocks formed by the process of crystallization from solid or liquid precursors. Some sedimentary rocks are also crystalline, e.g. limestones.

crystallography The study of crystals, including their form, structure, habit, and symmetry.

crystal symmetry In well-formed crystals, the symmetrically-arranged faces reflect the internal arrangement of atoms. The symmetry of individual crystals may be defined by reference to three elements: the plane of symmetry by which the crystal may be divided into two equal or 'mirror image' halves; the axis of symmetry, which is a line about which a crystal may be rotated so that it presents its original appearance or condition several times, i.e. at 180°, 120°, 90°, or 60° intervals, which correspond respectively to two-fold (diad), three-fold (triad), four-fold (tetrad), and six-fold (hexad) axes; and the centre of symmetry, which is a central point through which pass the lines connecting the equivalent faces or edges of the crystal. Using these elements of symmetry, crystallographers have recognized 32 crystal classes and seven crystal systems.

crystalwort (*Riccia glauca*) *See Riccia*.

ctenidial axis The junction of an inner and outer demibranch in molluscan demibranchiate gills. Two V-shaped demibranchs are joined to form a W-shaped gill. Gills of other shapes that are symmetrical about an axis may also be said to have a ctenidial axis.

ctenidium In aquatic Mollusca the respiratory, or in Lamellibranchia the food-collecting, surface or gill situated in the mantle cavity. *See also* Nyctiribidae.

ctenii *See* ctenoid scale.

Ctenizidae *See* trapdoor spiders.

Ctenocystoidea (phylum Echinodermata, subphylum Homalozoa) Class of echinoderms in which the body is small, ovoid, and flattened, consisting of a double, marginal frame of large ossicles, and a central area of small plates. At the anterior end a grill-like array of bladed plates probably covered the mouth. The class is known only from the Middle Cambrian of Utah and Idaho, USA.

Ctenodactylidae (gundis; order Rodentia, suborder Hystricomorpha) Family of small, ground-dwelling rodents of arid, rocky environments. The legs are short, and the digits are reduced to four on each foot, the two inner digits of the forefeet bearing bristles. The eyes are large, the ears rounded. The tail is short and fully haired. There are four genera, and eight species, occurring in N. Africa.

ctenoid scale Scale of bony fish characterized by the presence of many tiny, tooth-like processes (ctenii) in the posterior, or outer segment.

Ctenoluciidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish with an elongate, pike-like body, large mouth, and with the single dorsal and anal fins set far back on the body. They occur in C. and S. America.

Ctenomyidae (tuco-tucos; order Rodentia, suborder Hystricomorpha) Family of burrowing rodents in which the body is compact, the head large, the legs short and pentadactyl, with strong claws, and the soles of the feet bordered with bristles. The eyes and ears are small. The skull is strong and flattened, the occipital crests prominent, the paroccipital processes curved beneath the bullae. The cheek teeth are hypsodont, the last molar being vestigial. There is one genus (*Ctenomys*) and about 26 species, distributed widely throughout southern S. America.

Ctenopharyngodon idella (grass carp) *See* herbivorous fish.

Ctenophora ('comb jellies') Small phylum of carnivorous, hermaphroditic, marine animals, in which the body is biradially symmetrical and can be divided into two hemispheres, and into equal sections by eight ciliated bands, the 'combs' from which the phylum derives its common name. The cilia provide locomotive power in most species, although some lobate species swim by contracting the lobes. In the class Tentaculata two long, branched tentacles emerge from a deep epidermal canal on the aboral side of the body and are used to catch prey. Members of the class Nuda lack tentacles. Many ctenophores are spherical or ovoid, and 1–5 cm in diameter, but some are conical, cylindrical, or strap-like and one species of the genus *Cestum* grows to more than 1 m in length. Ctenophores have no definitive fossil record, but their body plan is similar to that of a medusa and they are believed to be descended from medusoid cnidarian. There are two classes (Tentaculata with four orders, and Nuda with one order) altogether comprising about 50 species, some of which occur in coastal waters throughout the world, and others of which are oceanic.

Ctenostomata (subphylum Ectoprocta, class Gymnolaemata) Order of bryozoans in which new individuals grow by budding from a slender, creeping tube (the stolon). The aperture of each zooid is closed by a fold of the body wall which bears bristle-like setae. The body wall is not calcified. The order first occurred in the Ordovician, and is still extant.

Ctenostomatida *See* Odontostomatida.

Cu *See* copper.

cubitus vein *See* Cu P.

cuboid bone Name sometimes given to each of the fourth and fifth distal tarsal bones.

Cubomedusae (subclass Scyphomedusae) Order of free medusae, whose members have a cuboid or quadrangular shape with four tentacles, or groups of tentacles, at the corners. They are inhabitants of warmer waters of the oceans, and also swarm in harbours and bays.

cuchia (*Amphipnous* (*Monopterus*) *cuchia*) *See* Amphipnoidae.

cuckoo bees *See* Anthophoridae; and Halictidae.

cuckoo-roller *See* Leptosomatidae.

cuckoos 1 *See* Cuculidae; Cuculiformes; *Cuculus*; and *Coccyzus*. 2 (common cuckoo, *Cuculus canorus*) *See Cuculus*. 3 (coucals) *See Centropus*. 4 (great spotted cuckoo, *Clamator glandarius*) *See Clamator*.

cuckoo-shrikes *See* Campephagidae; and *Coracina*.

cuckoo-spit insect *See* Cercopidae.

cuckoo wasp *See Vespula austriaca*.

Cuculidae (cuckoos, anis, couas, coucals; order Cuculiformes) Family of small to medium, long-tailed, generally short-legged birds. Most have a stout, slightly decurved bill, and their toes are zygodactylous or semizygodactylous. Most are arboreal, but some are terrestrial (e.g. *Geococcyx californianus*, great roadrunner). They are mainly insectivorous and many species are brood-parasitic; non-parasitic species build open nests in trees. They are mainly solitary, but *Crotophaga* species (anis) are gregarious and build communal nests. There are 35 genera, with 130 species, found worldwide.

Cuculiformes (cuckoos, touracos; class Aves) Order of two families, Cuculidae and Musophagidae, both having loose-webbed plumage and zygodactylous feet. Some authorities define them as separate orders.

cucullus In Ricinulei, a hinged plate attached to the carapace and covering the mouthparts.

Cuculus (cuckoos; family Cuculidae) Genus of grey or brown cuckoos with long tails and wings. Many have barred under-parts and closely resemble hawks. They are arboreal and insectivorous (feeding particularly on hairy caterpillars). They are brood-parasitic, each species choosing a variety of hosts. Many are migratory. There are 13 species, found in Europe, Africa, and from Asia south to Australia. The call of *C. canorus* (common cuckoo) gives rise to the family name.

Cuculus canorus (common cuckoo) *See Cuculus*.

cucumber (*Cucumis sativa*) *See* Curcurbitaceae.

cucumberfish *See* Chlorophthalmidae.

Cucumis melo (melon) *See* Cucurbitaceae.

Cucumis sativa (cucumber) *See* Cucurbitaceae.

Cucurbitaceae Family of a few shrubby members, but mostly of tendril-climbing herbs with weak, sappy stems, and palmate leaves. The tendrils are coiled spirally, and arise beside the leaf bases. The flowers are unisexual, often dioecious, with five petals often joined below. The fruits are berries, often very large. There are many important food plants, e.g. *Cucumis melo* (melon), *C. sativus* (cucumber), *Cucurbita pepo* (gourd), marrows, pumpkins, and squashes. There are some 90 genera, with 700 species, most of which are tropical or subtropical.

Cucurbita pepo (gourd) *See* Cucurbitaceae.

cud *See* ruminant.

cudbear Purple dye obtained from the lichen *Ochrolechia tartarea*. This lichen forms thick, grey to brownish-grey, rough, warty crusts on a range of substrates, including trees, rocks, soil, other lichens, etc. The dye used to be extracted from the lichen thalli by steeping them in urine.

cuesta Asymmetric land-form consisting of a steep scarp slope, and a more gentle dip (or back) slope. It is typical of areas underlain by strata of varying resistance that are dipping gently in one direction, and is intermediate between the flat-topped mesa and butte, and the more symmetric ridge form of the hogback.

Culex fatigans (*Culex pipiens fatigans*; mosquito) *See* Culicidae.

Culex pipiens fatigans *See* Culicidae.

Culicidae (mosquito, gnats; class Insecta, order Diptera, suborder Nematocera) Family of very slender flies, which generally have an elongate, piercing proboscis, and stiff palpi. The legs are long, the wings fringed with scales on the hind margins and along veins. The antennae of females are pilose, those of males plumose. Eggs are laid on or near the surface of water, singly or in compact masses as floating rafts. The transparent larva has a well-developed, mobile head, with dense tufts of bristles which are used to filter from the water the planktonic organisms and detritus on which the larva feeds, and with an anal respiratory siphon which it uses to renew its oxygen supply at the water surface after a period of submersion. The pupa is comma-shaped, very active, and able to swim beneath the water surface as a shadow passes across the surface. It breathes through a respiratory siphon held above the surface. Adult mosquitoes are well known as carriers of disease, especially those of the genera *Culex* and *Anopheles*. Males generally feed upon plant juices. Females have stronger, piercing mouthparts and feed upon the blood of vertebrates. These blood-feeding females act as intermediary hosts for malaria, yellow fever,

filariasis, dengue, and several other disease organisms. *Culex* (*pipiens*) *fatigans*, distributed throughout the tropics, is the carrier of *Wucheria bancrofti*, the nematode responsible for elephantiasis in humans. Adults of this species have a characteristic resting attitude, with the body almost parallel with the substrate. There are 3000 described species.

culmen Ridge along the upper mandible of a bird, from the tip of the bill to the forehead.

cultivation Tilling the soil by ploughing, digging, draining and/or smoothing. It is done in the course of seeding, transplanting, loosening soil, controlling weeds, or incorporating residues.

cultural (ethol.) Applied to the transmission of information from one generation of animals to another by non-genetic means, e.g. by imprinting or imitation. Behaviour may be modified culturally, so that while individuals usually behave in a traditional way, traditional behaviour in the same species may vary widely from one population to another.

cultural eutrophication *See* eutrophication.

cultural evolution Uniquely among species, the ability of humans to adapt and shape their environment. It is the result not only of biological evolution but also of cultural evolution, which embraces customs, beliefs, and the acquisition of knowledge. Adaptation by cultural change can be far more rapid than by genetic alteration.

cultural forestry Planting and management of trees on land that did not support woodland formerly, so that the result is entirely man-made.

culture 1 Population of micro-organisms or of the dissociated cells of a tissue grown, for experiment, in a nutrient medium: they multiply by asexual division. 2 Transfer of behavioural traits between individuals in a non-genetic manner, i.e. the traits are not inherited genetically although they may be passed from parent to offspring by verbal or visual communication. Culture is most developed in primates, particularly humans, but may also occur in other organisms such as social insects.

cumquat *See Fortunella*.

cumulonimbus From the Latin *cumulus* meaning 'heap' and *nimbus* meaning 'rain', a cloud of bulging, dense form, often towering to great height in unstable air. Young clouds have distinctive fibrous or lined features; older, glaciated types, with abundant ice crystals, are lustrous. Typically, the upper parts are spread into anvil or plume features. The cloud base is dark and usually gives rise to precipitation, often with virga. *See also* cloud classification.

cumulus From the Latin *cumulus* meaning 'heap', a dense, isolated, and clearly defined cloud with vertical growth in bulges or domes, and a flattened, darker base. Sharply outlined, bulging cloud tops indicate vigorous growth. Occasionally a more ragged form occurs. *See also* cloud classification.

Cunninghamellaceae (order Mucorales) Family of fungi in which sporangia and sporangiola are not formed. Asexual reproduction occurs by the formation of conidia. There are four genera, with several species, some of which are very rare. They are found in soil, dung, vegetation, etc.

Cunninghamia (family Taxodiaceae) Genus of tall, coniferous trees with long, flat, fine-pointed leaves, spirally arranged on twigs, but twisted so as to be pinnately arranged. Cones are ovoid and erect, with a small brown spine on the rounded tip of each white-fringed scale. There are two species, one of which occurs in SW China, and the other in Taiwan.

Cunoniaceae Family of trees and shrubs closely related to Staphyleaceae, in which the leaves are opposite, and simple or compound, with stipules. Flowers are small, and tetra- or pentamerous. The fruit is usually a capsule. There are 26 genera, with 250 species, centred in the temperate southern hemisphere, and extending to the tropics.

Cuon alpinus (cuon, dhole) *See* Canidae.

Cu P Posterior branch of the cubitus vein in the wings of insects. The cubitus forms one of the six main groups of veins. In the Lepidoptera it tends to be reduced or lost in the more advanced species.

cup fungi Fungi that form cup-shaped fruit bodies (apothecia), particularly members of the order Pezizales.

cup lichen Common name for one of those species of *Cladonia* whose podetia are shaped like miniature cups or wine glasses.

Cupressaceae (cypress) Family of conifers in which the leaves are in opposite pairs, scale-like and adpressed, or needle-like; and the cones are usually small, and globose to long. The scales of the cones have no spine tips. There are about 15 genera, with 100 species, distributed in the northern temperate zone, with outlying species in tropical mountains, and in temperate S. America.

Cupressus (cypress; family Cupressaceae) Genus of trees in which the twigs are not flattened in one plane; the leaves are scale-like, and in opposite pairs; and the scales of the cone are in 3–6 pairs, with peltate tips. The trees are much cultivated. There are about 12 species, occurring in the northern temperate zone.

cuprite (red copper ore) Mineral, specific gravity 5.8–6.1, hardness 3.5–4.0, chemical composition Cu_2O, whose name is derived from the Latin for 'copper'. It usually occurs in the oxidized zone of copper deposits, as a secondary mineral, and associated with malachite and azurite. It is distinguished by its colour, streak, and alteration to malachite. It is red to nearly black, and has a brownish-red streak, and an adamantine to sub-metallic lustre. It crystallizes in the cubic system. The crystals are usually octahedral and acicular, but they can be granular and rhombododecahedral. It is an ore mineral for copper.

cupulate Cup-shaped.

cupule Cup-like sheath surrounding or enclosing certain fruits, e.g. the acorn of *Quercus*.

curare Plant extract containing alkaloids that block the passage of nerve impulses at synaptic junctions

by competing with acetylcholine for receptor sites on the post-synaptic membrane. It is used by some S. American Indians as an arrow poison. *See also Strychnos*

curassows *See Crax*.

Curculionidae (weevils, snout beetles; class Insecta, order Coleoptera) Family of robust beetles, 1–50 mm long, in which the elytra is toughened, and often highly sculptured, with a pattern of coloured or metallic scales. Some are flightless, with fused elytra. The head is produced into a rostrum bearing mandibles at the tip; some are short and stout, others long and narrow, up to three times the length of the body. The antennae are elbowed and clubbed. Larvae are legless, grub-like, and are usually found inside a plant, or underground, at the roots. Many are crop pests. Adults of *Sitona lineatus* (pea weevil or bean weevil) attack leaves of leguminous plants. *Anthonomus grandis* (cotton-boll weevil) prevents the proper development of cotton flowers, causing serious economic loss. *Sitophilus granarius* (grain weevil) is a cosmopolitan pest of stored rice and flour products. There are 60 000 species, making it the largest beetle family.

Curcuma (family Zingiberaceae) Genus of five species of aromatic herbs which occur in subtropical and tropical Asia. The rhizomes of *C. longa* yield turmeric.

curlews 1 *See Numenius*; and Scolopacidae. 2 (stone-curlew) *See* Burhinidae.

currawongs *See* Cracticidae.

Cursorius (coursers; family Glareolidae) Genus of slim, sandy-coloured, plover-like birds with distinctive white stripes from eye to nape. They have slender, decurved bills; long legs; and feet that lack a hind toe, the middle toe being pectinate. They are terrestrial and good runners, inhabiting desert and open plains, feeding on seeds and insects, and nesting on the ground. There are three species, found in Africa, SW Asia, and India.

cuscus *See* Phalangeridae.

Cuscuta (dodder; family Convolvulaceae, tribe Cuscuta) Genus of climbing plants that are parasitic on many crop plants, to which they can cause serious damage. They have no green tissue, but thin, herbaceous stems and small flowers in ebracteate clusters. There are 170 species of tropical and temperate regions. They have become widespread along with the host plants.

cusk-eel *See* Ophidiidae.

cuspate foreland Large, triangular area of coastal deposition, which is dominated by many shingle ridges, and is often terminated landward by poorly drained terrain. It is the result of a long episode of local marine aggradation under wave advance from two dominant directions. Dungeness, on the south coast of England, is a typical example.

cuspidate Having a sharp tip or point.

custard apple *See Annona*.

cutan (clay films, clayskins, argillans, tonhautchens) Deposited skin or coating of material on the surfaces of peds and stones, which is usually composed of fine, clay-like soil particles which have been moved down through the soil.

cutaneous respiration In some vertebrates the body surface has become highly vascularized for gaseous exchange. Such exchange is of particular importance in the class Amphibia, where mucous glands in the skin maintain a moist respiratory surface; and in the soft-shelled turtles (family Trionychidae, order Chelonia (Testudines), class Reptilia).

cuticle 1 Thin, waxy, protective layer covering the surface of the leaves and stems of plants. 2 The outer layer of an insect, secreted by epidermal cells. The cuticle has a complex structure. Immediately above the epidermis is the Schmidt layer; above that an endocuticle of chitin; and above that an exocuticle of tanned chitin which is frequently dark in colour. There is a thin epicuticle covered with wax or grease. The precise nature of these layers (whether they are tanned, lamellar, etc.) varies from species to species, and also from place to place in the exoskeleton of an individual insect, according to its species. *See also* exoskeleton.

cutin The complex mixture of fatty-acid derivatives of which the cuticle of plants is composed.

cutlassfish *See* Trichiuridae.

cut-off Section of a river channel that no longer carries the main discharge. Its abandonment results from meander development associated with lateral channel migration across a floodplain. Channel length is shortened by contact at the neck of a loop, which becomes a cut-off, or 'ox bow'.

cut-off high Anticyclone isolated from the main subtropical belt of high pressure and around which the main flow of the upper westerlies is diverted, causing a blocking situation in middle latitudes.

cut-off low Cold low in mid-latitudes (occasionally almost in subtropical latitudes) where it is cut off from the main subpolar belt of low pressure. Sometimes a cut-off low occurs with a cut-off high over the higher latitudes, typically in blocking situations. In summer, weather associated with such slow-moving lows is unsettled and thundery.

cut-throat eel *See* Synaphobranchidae.

cuttlefish *See* Sepioidea.

cutworms *See* Noctuidae.

cwm *See* cirque.

Cyamus (whale lice) *See* Amphipoda.

Cyanobacteria (blue-green algae, Cyanophyta) Division of prokaryotic organisms which carry out photosynthesis in the presence of light and air with concomitant production of oxygen. Fossil cyanobacteria have been found in rocks almost 3000 million years old and they are common as stromatolite colonies in rocks 2300 million years old. They are believed to have been the first oxygen-producing organisms, and the oxygen they generated as a by-product of photosynthesis gradually enriched the atmosphere and influenced profoundly the subsequent course of evolution. The

organisms may be single-celled, filamentous, or colonial. Some are capable of a gliding motility when in contact with a solid surface. There are no chloroplasts: chlorophyll is carried on specialized membranes (thykaloids) within the cells. Many species can carry out the fixation of atmospheric nitrogen. Cyanobacteria are widely distributed and are found in freshwater and marine environments, on soil, on rocks, and on plants as epiphytes or as symbionts. More than 150 genera, and well over 1000 species, have been described. Although they are now regarded as close relatives of the bacteria, the cyanobacteria are still generally classified among the algae in botanical classification schemes.

Cyanophyta *See* Cyanobacteria.

cyanophyte Cyanobacterium (blue-green alga). *See* Cyanobacteria.

Cyatheaceae Family of ferns, most of which are massive tree ferns, with gradate sori arising at first marginally, and then deflecting to the under-side of the fronds, where they are protected by a pair of indusial flaps. *Cyathea* and *Dicksonia* are important tree-fern genera, the former being particularly prominent in moist New Zealand forests. There are some eight genera, occurring mainly in the tropics and moist, warm, temperate southern hemisphere. *See also* Thyrsopteridaceae.

cybernetics The study of communications systems and of system control in animals and machines. In the life sciences, it also includes the study of feedback controls in homoeostasis.

Cycadaceae The only living family of the ancient gymnosperm order of Cycadales, comprising plants with leaves and habit similar to those of palm trees, although some species are quite small. Cycads are dioecious: most bear large, coloured, female or male cones. Pollen grains have motile spermatozoa within them, which is a very primitive feature. Nine genera, and fewer than 100 species, exist today. All are tropical or subtropical. Four genera are American: *Zamia*, *Microcyas*, *Dioon*, and *Ceratozamia*; five are Old World: *Macrozamia* and *Bowenia* (Australian), *Stangeria* and *Encephalartos* (SE Africa only), and *Cycas* (widespread).

Cycadales Order of gymnosperms, of palm-like habit, with (usually) cone-like, separate male and female inflorescences, and motile male sperms. The order today includes just nine genera, hence the reference to cycads as 'living fossils'. Formerly they were much more important and, following their appearance in the Permian, remained important members of the world's Mesozoic floras. Their reduction was particularly marked in the Late Cretaceous, as they were progressively displaced by angiosperm trees.

Cycas (family Cycadaceae) Genus of stout trees which differ from other Cycadaceae in that the female plants do not bear cones, but carry ovules (and seeds) on massive, terminal, leaf-like sporophylls, which is a primitive feature. There is a terminal crown of long, finely pinnate leaves, in which the leaflets are flat. They are dioecious. A few yield edible starch (sago) from the central pith, nowadays used only as a famine food. There are 16–20 species, occurring from Madagascar and tropical Asia to the Pacific islands and Australia.

Cyclamen (family Primulaceae) Genus of herbs with large corms, from which arise the simple leaves and the solitary, nodding flowers on long, leafless stalks with large, reflexed corolla lobes. They are grown widely for their showy flowers. There are some 15 species in NW warm, temperate regions of the Old World.

Cyclanthaceae Family of palm-like plants which may be rhizomatous herbs, shrubs, or root-climbers. The leaves are always very deeply bilobed, and plicate. The flowers are unisexual, and borne on axillary spadices enclosed in conspicuous bracts (spathes). The fruit is a fleshy syncarp, and brightly coloured. There are 11 genera, with 180 species, occurring in tropical America.

Cyclarhidae (pepper-shrikes) *See* Vireonidae.

Cyclas formicarius (sweet-potato weevil) *See* Apionidae.

cycle of erosion Orderly series of stages through which landforms were believed to pass from their initiation following uplift to their final planation by erosion. The main stages were those of youth, when hillslopes were steep and river profiles irregular; of maturity, when river profiles were smoothly concave up and incision had markedly slowed; and of old age, when the landscape was reduced to a gently undulating surface or peneplain. This framework for landform studies has now largely dropped out of use.

cyclic-AMP *See* c-AMP.

cyclic-GMP *See* guanosine phosphate.

cyclic phosphorylation The synthesis of ATP during photosynthesis, coupled to the cyclic passage of electrons to and from pigment system I using a series of carrier molecules.

cycling pool *See* active pool.

Cyclocystoidea (phylum Echinodermata, subphylum Echinozoa) Class of free-living echinoderms in which a single, marginal ring of cuboidal ossicles surrounds a disc-shaped central area bearing numerous small plates on both dorsal and ventral surfaces. The ventral plates are radially aligned into rays and inter-rays, surrounding the centrally placed mouth. The class is known from the Ordovician to Devonian.

cyclogenesis Formation and strengthening of cyclonic air circulation, tending to form or deepen depressions. The process is associated with upper-air divergence over or near the frontal zone.

cycloid scale Scale of bony fish characterized by the absence of tooth-like processes, the edge being smooth all round.

cyclolysis The processes of dissipation of cyclonic air circulation around a depression, or the weakening of lesser cyclonic features.

cyclomorphosis Seasonal change in body shape found in rotifers (phylum Rotifera), and in cladoceran Crustacea (phylum Arthropoda). In

cladocerans, e.g. *Daphnia* species, the changes in shape involve the head, which is rounded from midsummer to spring and then progressively becomes helmet-shaped from spring to summer, reverting to the rounded shape by midsummer. The process is poorly understood and may be the result of genetic factors interacting with external conditions, e.g. temperature or day length, or, as in rotifers, the result of internal factors alone.

cyclone *See* hurricane.

Cyclophyllidea (Taenioidea; phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms which possess a relatively complex, suckered scolex. Genitals are often repeated. Two hosts are inhabited during development.

Cyclopteridae (lumpsucker, sea-snail; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Large family of marine, cold-water fish with thick-set, almost rotund, short bodies. The presence of a sucking disc formed by modifications of the ventral fins is characteristic of the family. The lumpfish have a deep body, and the scaleless skin bears many rows of bony thorns. Both second dorsal and anal fins are short. *Cyclopterus lumpus* (Atlantic lumpsucker) is found on both sides of the N. Atlantic, with the larger males sometimes exceeding 35 cm in length. Occasionally they are caught in fishing nets. Treated with salt and black pigment, the roe is at times sold as cheap caviar. Atlantic snailfish, e.g. *Liparis liparis*, also have a scaleless skin, but no bony thorns or denticles. The dorsal and anal fins are much longer than those of the lumpsucker, but snailfish are also bottom-dwelling. There are about 140 species, found in the colder waters of the N. Atlantic and Antarctic.

Cyclorhagida (phylum Aschelminthes, class Kinorhyncha) Order of aschelminth worms in which the head is covered on retraction by platelets on the second segment of the body.

Cyclorrapha (class Insecta, order Diptera) Suborder of true flies which is normally divided into two sections, Aschiza and Schizophora, comprising insects whose antennae have less than six segments and have, or lack, a ptilinal suture. The antennae usually have three segments, with a terminal arista. The wing venation includes a closed discal cell with the cubital cell closed or contracted. The larvae have a vestigial head, and pupate within a puparium. The suborder includes 57 families.

cyclosis Protoplasmic streaming within a cell moving at about 1–5 cm/h.

Cyclostomata 1 (subphylum Ectoprocta, class Gymnolaemata) Order of bryozoans in which the colony is made up of thin-walled, finely perforate, calcareous tubes. The aperture of each individual is rounded, without any covering. Reproduction and larval development take place in a single, enlarged individual called an 'ovicell'. The order appeared in the Ordovician and exists at the present day. 2 (Agnatha, Marsipobranchii) The group comprising the most primitive living vertebrates, also called jawless fish. They are characterized by the absence of jaws and paired fins, by a series of gill pouches rather than gill slits, by a cartilaginous skeleton without proper vertebrae, and by never having more than two semicircular canals. The taxonomic status of the term 'Cyclostomata' is somewhat confused: at various times it has been ranked as order, superorder, subclass, and class. The extant species usually included are the lampreys (Petromyzonidae) and the hagfish (Myxinidae).

cyclothem Unit, or given set of deposits, laid down as a result of either cyclic or rhythmic sedimentation. In a cyclic sequence the cyclothem would represent the whole succession, e.g. 1234321, whereas in a rhythmic sequence the cyclothem units would be repeated, e.g. 12341234.

Cydippida *See* Cydippidea.

Cydippidea (Cydippida; class Tentaculata) Order of ctenophorids which possess a body that may be slightly compressed. There are two retractable tentacles at the opposite end of the body to the mouth. Only one species adopts an endoparasitic mode of life.

Cygnus (swans; family Anatidae) Genus of large, long-necked, white or black wildfowl, the heaviest of all flying birds. They are found by lakes and rivers, feeding on submerged vegetation and also grazing fields. They nest on the ground, two species breeding in arctic tundra and migrating south in winter. They are frequently found in captivity. *C. olor* (mute swan) is widely domesticated, and *C. atratus* (black swan) has been introduced to New Zealand. There are five species, found in Europe, Asia, N. and S. America, and Australia.

Cygnus atratus (black swan) *See Cygnus*.

Cygnus olor (mute swan) *See Cygnus*.

Cylindrachetidae (class Insecta, order Orthoptera, suborder Caelifera) Family of medium-sized, wholly subterrannean caeliferans which bear a superficial resemblance to Gryllotalpidae (mole crickets). Wings are absent, and the general body and leg structure is highly modified for burrowing. Only seven species have been described. Five occur in Australia, one in New Guinea, and one in Patagonia.

cyme Inflorescence in which each axis ends in a flower; the oldest flowers are in the centre, younger ones are produced successively from the axils of bracteoles. Growth is sympodial.

cymose In the form of, or resembling, a cyme.

Cynipidae (suborder Apocrita, superfamily Cynipoidea) Family of insects: it is divided into several subfamilies, but the great majority of its members belong to the subfamily Cynipinae (gall wasps). Gall wasps cause galls on a variety of plants, particularly *Quercus*. Each species forms a characteristic gall on its host plant, the larva or larvae developing inside. Galls may be unilocular or multilocular (containing one, or more than one, larva). The life cycle is often complex and heterogynous (with alternating sexual and agamic generations occurring on different parts of the host plant, and sometimes on different host plants). In the past, adults produced from the two different generations of the same species were

described as different species owing to the apparent lack of similarity. Other members of the Cynipidae are dipteran parasites, hyperparasites of aphidiine Braconidae, and inquilines in the galls of other gall wasps (inhabiting the host gall without parasitizing the other occupant). Adults are usually shiny, black to brown, with straight antennae, and laterally compressed abdomen. They are 2–8 mm long.

Cynipinae (gall wasps; superfamily Cynipoidea, family Cynipidae) Subfamily of insects whose larvae induce gall formation on many different species of plant. Galls arising from cynipid attack have names such as: oak apple, oak marble, spangle gall, artichoke gall, and Robin's pincushion. Plant galls, and the way in which insects are able to produce species-specific and often highly complex structures are little understood.

Cynocephalidae (flying lemurs, colugos; order Insectivora, suborder Dermoptera) Family of nocturnal, herbivorous, arboreal animals whose limbs support a patagium extending from the sides of the body to the paws, and from the neck to the tip of the tail, by means of which they glide. The digits are flattened, and the soles of the paws form sucking discs for adhesion. The teeth are sharp, the lower incisors procumbent and each divided into many prongs, like a comb. The upper incisors are positioned at the sides of the jaw, leaving the front of the jaw toothless. The canines resemble premolars. There is one genus (*Cynocephalus*), and two species, distributed throughout SE Asia.

Cynocrambaceae (Theligonaceae; order Haloragales) Small family of annual and perennial dicotyledonous herbs. The leaves are simple and fleshy, the lower ones opposite, the upper ones alternate, with fused pairs of membranaceous stipules. The flowers are in unisexual clusters of 1–3, the males globose, the females tubular. The ovary is a single carpel, developing into a nut-like drupe with a fleshy endosperm, which is dispersed by ants. The family comprises one genus, with two or three species, from the Mediterranean region, China, and Japan.

Cynodontidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish with an elongate body, large, oblique mouth, and small dorsal as well as adipose fins. They are found in the rivers of S. America.

Cynoglossidae (tonguefish, tonguesole; class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Small family of marine, warm-water flatfish. They are left-eyed fish, with the dorsal and anal fins continuous with the pointed tail-fin. Most species do not exceed 20 cm in length, but some, e.g. *Rhinoplagusia japonica*, found off Japan, are of commercial importance. There are about 85 species, found in tropical and subtropical waters.

Cynometra (family Leguminosae, subfamily Caesalpinioideae) Genus of trees with pinnate leaves, and small flowers which are borne in racemes, and which are sometimes cauliflorous. The pod is indehiscent, with one seed. They yield useful timber. There are 200 species, with a pantropical distribution, occurring in lowland rain forests.

Cynomys (prairie dog) *See* Sciuridae.

Cyperaceae Family of monocotyledonous herbs of grass-like habit, and inconspicuous, wind-pollinated flowers; but with solid, often trigonous (triangular in cross-section) stems, and three-ranked leaves. They occur mostly in wet places or on poor soils. The family contains some garden plants, but they are of little economic importance. There are about 100 genera, with 3000 species.

Cyperus (family Cyperaceae) Genus of usually perennial herbs with stolons, tubers, or rhizomes. They have erect stems with a leafy base. Flowers are borne in a terminal umbel. The fruits are trigonous (three-angled) nuts. *C. papyrus* (paper-reed) is a riverside plant growing up to 4 m high whose stems used to be split into thin strips to make papyrus paper. There are 550 species, found in tropical and warm temperate regions.

Cyperus papyrus (paper-reed) *See Cyperus*.

cyphella (pl. cyphellae) Shallow depressions or pores, found in lichens of the genus *Sticta*, which are visible in the lower surface of the thallus as small white pits.

cypress 1 *See* Cupressaceae; and *Cupressus*. 2 (swamp cypress, *Actinostrobus pyramidalis*) *See Actinostrobus*.

Cyprinidae (carp, minnow; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) In terms of numbers of species, by far the largest family of fish. It comprises freshwater fish that typically have a fairly elongate body, a single dorsal fin without true spines, a forked tail-fin, ventral fins in the abdominal position, and no teeth on the jaws (although pharyngeal teeth may be present). Cyprinidae range in size from *Rasbora maculata* (dwarf rasbora), measuring 3 cm to *Barbus tor* (mahseer), which reaches a length of 1.6 m. Many cyprinids are herbivorous, feeding on plants or algae. Many are also of considerable commercial importance as food fish (e.g. carp) or hobby fish (e.g. goldfish). The culture of *Cyprinus carpio* (carp) in ponds was established in parts of Europe and Asia several centuries ago. Many species are very popular with aquarium hobbyists. These include *Carassius auratus* (goldfish), *Barbus tetrazona* (tiger barb), *Rasbora heteromorpha* (harlequin), and *Brachydanio rerio* (zebra danio). Others, e.g. *Tinca tinca* (tench) and *Rutilus rutilus* (roach), are popular with anglers in Europe. There are about 1600 species, occurring worldwide, but absent from S. and C. America, Madagascar, Australia, New Guinea, and New Zealand.

Cypriniformes Order of carp-like fish. Typical freshwater inhabitants, the fins lack proper spines; the single dorsal fin is usually half-way down the back, opposite the ventral fins in the abdominal position; an adipose fin is present in some families. The order includes some 26 families, e.g. the Characidae (tetras), the Cyprinidae (carps), and the Catostomidae (suckers).

Cyprinodontidae (killifish, toothcarp; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Large family of small fresh- to brackish-water fish, with a single dorsal fin opposite the anal

fin. The slender body ends in a truncate or rounded tail-fin. There is no lateral line. There are teeth in the jaws. The cyprinodonts include many well known, colourful fish species, e.g. *Jordanella floridae* (American flagfish), *Aphyosemion arnoldi* (Arnold's lyretail), and *Rivulus ocellatus* (eyed rivulus). Several species are known to enter brackish water or even sea water; these include *Fundulus heteroclitus* (killifish). There are about 300 species, found in most tropical freshwater systems of the world.

Cyprinus carpio (carp) *See* Cyprinidae.

Cypripedium *See* Orchidaceae.

cypris larva Non-feeding larval stage in barnacles (class Cirripedia), which follows the six planktonic nauplius instars. The cypris larva is the settling stage, and attaches to the substrate by means of cement secreted by glands in the first antennae. The body is enveloped in a bivalved carapace and the pair of compound eyes is sessile; there are six pairs of thoracic appendages.

Cyrillaceae (order Ericales) Small family of deciduous or evergreen shrubs and small trees. The leaves are simple and alternate. The flowers are borne in racemes and have five sepals and five petals, which may be free or fused. The superior ovary develops into a capsule or drupe, sometimes winged, with a fleshy endosperm. *Cyrilla racemosa* (leatherwood) and *Cliftonia monophylla* (buckwheat tree) are grown as ornamentals, and have attractive white flowers and reddish autumn foliage. There are three genera, with about 14 species, mostly from tropical America.

Cyrilla racemosa (leatherwood) *See* Cyrillaceae.

cyrtoconic Applied to the conch of a cephalopod when it is a curved, tapering cone.

Cyrtocrinida (class Crinoidea, subclass Articulata) Order of crinoids in which the cup consists of large radial plates and a single dorsal plate which is probably a modified column. The column is short or absent; the arms are short and stout, and may completely cover the ventral surface of the animal when withdrawn. The order is restricted to hard substrata (e.g. hardgrounds and reefs), and is known from the Lower Jurassic to the present.

Cyrtophorina (order Gymnostomatida) Suborder of ciliate protozoa in which the cytostome is located on the ventral side of the body. The organisms feed on diatoms, algae, and bacteria, which are ingested through the non-expansible cytostome.

Cyrtosperma (family Araceae) Genus of rhizomatous herbs several of which are gathered wild for food. *C. chamissonis* (giant swamp taro), cultivated in Micronesia and parts of Melanesia, thrives over coral. There are 18 species, occurring in the eastern tropics.

Cyrtostachys (family Palmae) Genus of clump-forming palms which have pinnate leaves, and a prominent crown-shaft. The pendulous inflorescence occurs below the crown-shaft, and has two big spathes, the flowers being in triads of a female and twin males. *C. lakka* (sealing-wax palm) of swamp forest, is much cultivated for its scarlet crown-shaft. There are eight species, occurring in rain forests from Malaya to the Solomon Islands.

cyst (bacteriol.) Thick-walled resting cell formed by bacteria of the genus *Azotobacter*.

cysteine Aliphatic, polar, alpha-amino acid that contains a sulphydryl group.

cystidium Type of enlarged, sterile cell, which occurs among the basidia in the hymenium of certain basidiomycetes.

cystine Amino-acid dimer formed from two cysteine residues linked by a sulphydryl bond.

Cystoidea Class of echinoderms, which are rare as fossils, ranging from the Lower Ordovician to the Middle Devonian.

Cystopteris (family Aspleniaceae) Genus of ferns characterized by their orbicular (disc-shaped) sori borne on receptacles on their own vascular strands, with inflated, bladder-like indusia. There are about 18 species, of cosmopolitan distribution.

Cystoseiraceae (order Fucales) Family of brown seaweeds in which the thallus is typically extensively branched and bushy in appearance. They are found chiefly in warmer regions in deep rock pools, or below low-water mark.

cytidine The nucleoside formed when cytosine is linked to ribose sugar.

cytochrome One of a group of haemoproteins, which are classified into four groups designated a, b, c, and d. They function as electron carriers in a variety of redox reactions in virtually all aerobic organisms.

cytochrome oxidase Enzyme containing both copper and iron that, because of its ability (unique among the cytochromes) to reduce molecular oxygen to water, catalyses the terminal reaction in oxidative phosphorylation.

cytogenetics The scientific discipline that combines cytology (the study of the structure, function, and life history of the cell) with genetics (the study of heredity). This usually involves microscopic studies of chromosomes.

cytokinesis *See* mitosis.

cytokinin One of a group of plant hormones including kinetin that act synergistically with auxins to promote cell division.

Cytophagaceae (order Cytophagales) Family of gliding bacteria which are rod-shaped or filamentous. Filaments may be coiled or branched, and may be enclosed in a sheath. They contain yellow, orange, or red pigments. They are chemo-organotrophs. Some species can attack polysaccharides such as cellulose and chitin. There are at least six genera, found in soil and in freshwater or marine habitats.

Cytophagales Order of Gram-negative bacteria in which at least some stages are capable of a gliding motility when in contact with a solid surface, and which form rods or thread-like filaments. Families

include Cytophagaceae, Beggiatoaceae, and Leucotrichaceae. They are found in soil and various aquatic habitats.

cytopharynx In some protozoan cells, a short, passage-like region through which food passes after being ingested at the cytostome.

cytoplasm The part of a cell that is enclosed by the plasma membrane, but excluding the nucleus.

cytoplasmic inheritance Non-Mendelian (extrachromosomal) inheritance via genes in cytoplasmic organelles. Examples of such organelles are viruses, mitochondria, and plastids.

cytoplasmic streaming The continuous, often rapid, movement of cytoplasm within a cell. It is a process requiring expenditure of energy by the cell and is thought to involve microfilament and microtubular activity.

cytosine Pyrimidine base in both DNA and RNA.

cytostome Site in a protozoan cell at which food is ingested: the cell's 'mouth'.

D

2,4-D (2,4-dichlorophenoxyacetic acid) *See* auxin.

dabberlocks Common name for the seaweed *Alaria esculenta*. The midribs of young plants are said to be edible.

dabbling ducks *See Anas*.

Dacelo novaeguineae (kookaburra) *See* Alcedinidae.

Dacrydium (family Podocarpaceae) Genus of coniferous trees in which the leaves are spiral or aplanate, and scale- or needle-like. Pollen cones are small, and the female cones usually have only one ovule. The seed is solitary, and seated on a cup-like structure. There are 20–25 species, occurring from Hainan and Indo-Malaysia to Australia, New Zealand, and Melanesia, with one species in Chile.

Dacrydium elatum (sempilor) Coniferous timber tree of the lowland tropical rain forests of the Malay archipelago.

Dacrymyces (family Dacrymycetaceae) Genus of fungi which typically form flattened, cushion-like, or wrinkled gelatinous fruit bodies. *D. deliquescens* forms small, orange, jelly-like cushions on wet, rotting wood. It is very common throughout the year.

Dacrymycetaceae (order Dacrymycetales) Family of fungi with the characteristics of the order. There are nine genera.

Dacrymycetales (subclass Holobasidiomycetidae) Order of fungi which form forked basidia. The fruit body is typically gelatinous. These fungi are saprotrophic. There is one family, found on decaying wood.

Dacryoconarida (phylum Mollusca, class Cricoconarida) Order of small cricoconarids whose tear-shaped embryonic chambers may possess a small apical spine. The shell wall may be thick or thin, and septa are not present. The juvenile chamber is externally smoother than the rest of the shell, which has ripple-like rings and, usually, longitudinal ornament. Some forms are smooth. The class ranges in age from Middle Silurian to Upper Devonian.

Dacryodes (family Burseraceae) Genus of resinous trees in which the leaves are pinnate, with stipules. Their fruit is a drupe. They produce heavy, often siliceous timber. There are 40 species, found in lowland tropical rain forests, with a pantropical distribution.

Dactylis (cocksfoot grasses; family Gramineae) Genus of important pasture grasses in which the panicles are compound, with long, stiff lower branches, and in which the spikelets and leafy shoots are compressed. There are about three species, found in the northern temperate regions of the Old World.

Dactylochirotida (subclass Dendrochirotacea) Order of holothuroids with digitate or feebly branched tentacles.

Dactylocladus (family Crypteroniaceae) Genus comprising one species (*D. stenostachys*) of trees of the Bornean peat-swamp forests, yielding the timber jongkong.

Dactylophora nigricans (dusky morwong) *See* Cheilodactylidae.

Dactylopteridae (flying gurnard; class Osteichthyes, subclass Actinopterygii, order Dactylopteriformes) Small family of marine, tropical to subtropical fish which have a somewhat bizarre profile. The very large pectoral fins are wing-like, the fin tips reaching the tail-fin when folded. Two free spines preceding the first dorsal fin are well forward on the back. The pelvic fins can be used by the fish to 'walk' on the sea-bottom, whereas the pectoral 'wings' are used to glide over it. There are about four species, widely distributed in coastal areas. The fairly common *Dactylopterus volitans* grows to 35 cm.

Dactylopteriformes Order of marine fish including only the family Dactylopteridae.

Dactylopterus volitans (flying gurnard) *See* Dactylopteridae.

Dactylosargus arctidens (southern sea carp) *See* Aplodactylidae.

Dactyloscopidae (sand stargazer; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of mainly marine, tropical fish, characterized by a somewhat bulky head; a large and almost vertical mouth; eyes positioned on top of the head; and long dorsal and anal fins, the anal fin originating well forward under the spinous dorsal. The lateral line is well developed. The fish tend to bury themselves in the sand with only part of the head free, awaiting the arrival of unsuspecting prey animals. There are about 20 Atlantic and Pacific species.

dactylozooid In some colonial coelenterates, a defensive or protective polyp.

daddy-long-legs *See* Tipulidae.

Daedalea (family Polyporaceae) Genus of fungi in which elongated, maze-like pores occur on the under-side of a thick, brown, hoof-shaped, corky or woody fruit body. In *D. quercina* the upper surface is greyish-brown, often with concentric bands or furrows. This species is common throughout the year on stumps of oak and other trees.

Daemonorops (family Palmae) Genus of climbing palms (rattans) which occur solitarily, or as clumps, and which range from stemless rosettes to high-climbing plants. The leaf sheaths are spiny; the leaves pinnate with a terminal, spiny whip

(cirrus). The plants are dioecious. The inflorescences have bracts which split along their length at maturity. The fruits are scaly, and the seed is usually single, with a sarcotesta. Some provide cane and a few the resin known as dragon's blood. In several, ants inhabit tunnels between spiny flanges on the leaf sheaths. *Daemonorops* is the second largest genus of climbing palms, with about 114 species, found in NE India, S. China, and east to New Guinea, with most occurring in Sumatra, Malaya, and Borneo.

daffodil *See Narcissus*.

daisy *See Bellis*.

daisy bush *See Olearia*.

Dalbergia (family Leguminosae, subfamily Papilionatae) Genus of trees and woody climbers, in which the leaves are usually pinnate. The pod is indehiscent, with one to a few seeds. Several species produce the fine cabinet timbers known as rosewood, Brazil tulipwood, and Burma tulipwood. There are more than 100 species, occurring in the tropics and subtropics.

Daldinia (family Xylariaceae) Genus of fungi in which the dark-coloured, hemispherical fruit bodies are about 5–10 cm in diameter and are formed annually. When cut open the fruit bodies show very characteristic concentric bands of black and white. Early in the season the surface is coated with pale-brown, powdery conidia. Later, perithecia are formed in the outer layer of the fruit body. *Daldinia* is found chiefly on ash (*Fraxinus excelsior*).

Dalradian The last, or youngest, stratigraphic unit of the Precambrian of Scotland and Ireland.

Dama (fallow deer) *See* Cervidae.

dammar Resinous exudate of *Agathis*, some Burseraceae, and many Dipterocarpaceae in the rain forests of Malesia. It is still in demand for specialist vanishes.

damping-off Disease of young seedlings, in which the stems decay at ground level and the seedlings collapse. It may be caused by any of a number of fungi, including species of *Pythium* and *Rhizoctonia*.

damselfish (*Chromis chromis*) *See* Pomacentridae.

damselflies *See* Amphiterygidae; Calopterygidae; *Calopteryx virgo*; Chlorocyphidae; Chlorolestidae; Coenagrionidae; Epallaginidae; Heliocharitidae; Hemiphlebiidae; Lestidae; Lestoideidae; Megapodagrionidae; Odonata; Platycnemidae; Platystictidae; Polythoridae; Protoneuridae; Pseudostigmatidae; *Pyrrhosoma nymphula*; and Zygoptera.

Danainae (tiger butterflies, crow butterflies; order Lepidoptera, family Nymphalidae) Subfamily of medium to large butterflies, usually orange and marked with black and yellow. The larvae have at least two pairs of fleshy filaments dorsally. Both adults and larvae have bright warning colours, and are distasteful and usually poisonous. They are distributed widely, but are found mainly in tropical Africa and SE Asia.

dance flies *See* Empididae.

dance language The ritualized behaviour by which a returned worker honeybee (*Apis* species) communicates the quality and source of food to other workers. There are two dances, both performed in the darkness of the nest or hive, on the vertical wax comb. The 'round' dance conveys the presence and quality of a food source close to the nest; no directional information is given. It comprises runs in a small circle, with regular changes of direction. The more frequent the change of direction, the greater the profitability of the food source (i.e. the greater its calorific value). Workers of foraging age pay particular attention to the pollen carried by the dancer and constantly antennate her (touch her with their antennae). Presumably they identify the source of the pollen by its characteristic scent and are then recruited to exploit the nearby source of food. The 'waggle' dance conveys a wider range of information, relating to the distance and direction of the food source, as well as to its quality. It refers to more distant sources of food than does the round dance, and often recruits workers to exploit flowers several kilometres from the nest. The waggle dance comprises runs in a flattened figure-of-eight pattern, with the waggle action performed in the straight run between the two rounds of the figure. The duration and vigour of the waggle are scaled to indicate distance, as is the loudness and duration of the buzzing associated with the waggle. Direction is indicated by the angle by which the straight run deviates from the vertical, the angle being equal to the angle between the direction of the food source and the sun as seen at that time from the nest entrance. Workers recruited by this dance will fly on a course that maintains this angle until they reach the food source, which they recognize by olfactory cues picked up earlier by antennation of the dancing worker in the hive. The dance language can be regarded as a ritualized enactment or 'charade' of the foraging flight made by the dancing worker. The language varies slightly between one geographic race of honeybees and another, and thus resembles bird-song and human languages in having local dialects.

dandelion *See Taraxacum*.

Danian The oldest of the Cenozoic stages, which in Denmark is characterized by chalky limestone rich in reef-dwelling organisms. It is a problematic stage once referred to the Cretaceous but now placed at the base of the Palaeocene.

Danthonia (family Gramineae, subfamily Arundinoideae, tribe Danthonieae) Genus of plants bearing panicles of spikelets with 2–10 flowers, and a ligule that is a line of hairs. The genus is large and found throughout the tropical and temperate world, but especially in S. Africa (10 species) and Australia (33 endemic species).

Daphaenosittidae (Neosittidae; sittellas; order Passeriformes) Family of small grey-brown birds with black and white markings on their heads, white-tipped tails, pale rumps, and coloured wing patches. They have thin, slightly hooked bills, long wings, short tails, and short legs with long toes. They are found in forests. They climb up and down trees, feed on insects and nest in trees. There are

two genera, with three species found in Australia and New Guinea.

Daphnia (water flea) *See* Cladocera; and cyclomorphosis.

Daphniphyllaceae Small family of trees in which the leaves are simple. The flowers are small, unisexual, and apetalous. The fruit is a drupe. The family is related to Magnoliaceae or Hamamelidaceae, and is often erroneously placed near Euphorbiaceae. There is one genus, comprising 10 species, occurring in E. Asia and Malesia.

Daption (cape petrel; family Procellariidae) Monotypic genus comprising *D. capense* (cape petrel or cape pigeon). It is a medium-sized pied petrel with a black head, black and white wings, and a black-spotted white rump and tail. It has a broad bill with a short nasal tube. It is oceanic, following ships and feeding on surface scraps. It nests on the ground in Antarctica and on sub-antarctic islands, ranging throughout the southern oceans.

Daption capense (cape petrel, cape pigeon) *See Daption*.

dark bottle Bottle covered with tape, or similarly adapted, to exclude light: it is used to monitor respiration rates in aquatic productivity experiments. *See also* oxygen method.

dark-green whip snake *See Coluber viridiflavus*.

darkling beetle *See* Tenebrionidae.

dark mildew 1 Either a fungus belonging to the family Perisporiaceae, or a plant disease caused by such a fungus. 2 *See* sooty mould.

Darling's disease *See* histoplasmosis.

Darlingtonia californica California pitcher plant.

darter *See Anhinga*.

Darwin, Charles Robert (1809–82) English naturalist who is remembered mainly for his theory of evolution, which he based largely on observations made in 1832–6 during a voyage around the world on HMS *Beagle*, which was engaged on a mapping survey. In 1858, in collaboration with Alfred Russel Wallace (who had reached similar conclusions), he published through the Linnaean Society a short paper, *A theory of evolution by natural selection*; and in 1859 he published a longer account in his book, *On the Origin of Species by Means of Natural Selection*. In this he presented powerful evidence suggesting that change (evolution) has occurred among species, and proposed natural selection as the mechanism by which it occurs. The theory may be summarized as follows: (a) The individuals of a species show variation. (b) On average, more offspring are produced than are needed to replace their parents. (c) Populations cannot expand indefinitely and, on average, population sizes remain stable. (d) Therefore there must be competition for survival. (e) Therefore the best-adapted variants (the fittest) survive. Since environmental conditions change over long periods of time, a process of natural selection occurs which favours the emergence of different variants and ultimately of new species (the 'origin of species'). This theory is known as Darwinism. The subsequent discovery of chromosomes and genes, and the development of the science of genetics, have led to a better understanding of the ways in which variation may be caused. Modified by this modern knowledge, Darwin's theory is called 'neo-Darwinism'.

darwin Measure of evolutionary rate, given in units of change per unit time.

Darwinia (family Myrtaceae, tribe Chamelaucieae) Genus of heath-like shrubs found in semi-arid regions on heaths of low fertility. The shrubs are prostrate to upright in form, with small, crowded leaves, and small flowers with a conspicuous pistil which in some species is surrounded by coloured bracts. There are 28 species, endemic to Australia.

Darwinian fitness *See* fitness; and selection.

Darwin's finches Fourteen species of Geospizinae that are endemic to the Galápagos Islands. There are only six species of all other passerine birds and one species of cuckoo on the islands. Thus it is inferred that an ancestor of the finches arrived on the islands before other birds and then underwent adaptive radiation. Each species has evolved a distinctive beak type, and feeds on food not eaten by the other species.

Darwin's frog *See Rhinoderma darwinii*.

Darwin's rhea (*Pterocnemia pennatus*) *See Rhea*.

Dascyllus aruanus (banded humbug) *See* Pomacentridae.

dasheen (*Colocasia esculenta*) *See Colocasia*.

dassies *See* Hyracoidea.

Dasyatidae (stingrays; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Family of mainly marine rays of temperate to warm waters. Several species are found in fresh water. Typically, these rays have one or two stout, serrated spines half-way down the back of the tail. Wounds inflicted by these spines can be very painful. Dorsal fins are usually absent; the head profile is continuous with that of the pectoral fins. Some species are found in trawl nets at depths of more than 100 fathoms (183 m), others are estuarine carnivores (and unpopular with oyster farmers). One of the larger stingrays is *Dasyatis brevicaudata* (smooth stingray) of E. Australia (3.5 m). The butterfly rays, which have a very short tail and a very wide body disc, are often included in this family. There are about 65 species, distributed worldwide.

Dasyatis brevicaudata (smooth stingray) *See* Dasyatidae.

Dasycladales (class Chlorophyceae) Order of green algae in which the vegetative thallus contains a single nucleus, becoming multinucleate immediately prior to reproduction; the thallus consists of an erect axis with branches, the whole showing radial symmetry. The order includes two families, the members of one being extinct. Most members show some degree of calcification.

Dasymutilla occidentalis (cow killer, mule killer; superfamily Scolioidea, family Mutillidae) Species

of large, red and brightly black and white banded wasps, whose females have a powerful sting, are wingless, and are covered in dense, velvety hair. Contrary to the implication of its common names, it does not kill cows or mules.

Dasypeltis *See* egg-eating snake.

Dasypoda *See* Melittidae.

Dasypodidae *See* Dasypodoidea.

Dasypodoidea (armadillos; order Edentata, suborder Xenarthra, infra-order Cingulata) Superfamily comprising the single family Dasypodidae, the armadillos, the oldest known of all S. American edentates and the only types known there from the Palaeocene and early Eocene. The armadillos are terrestrial, burrowing, omnivorous animals in which the head is flattened dorsoventrally, the tongue is elongated, and the ears are prominent. In different genera there are usually 14–50 homodont teeth, but up to 90 have been recorded. There are seven cervical vertebrae, some fused together. There are five digits on the hind limbs, and the forelimbs possess 3–5 claws used in digging. The tail is short, and usually encased in rings of bone. The upper and lower body surfaces are encased in transverse bands of bony scutes beneath horny plates. There is flexible skin between the plates, permitting some species to roll into a ball. Hair is present on the lower surface and between plates. Armadillos are very successful animals, distributed widely through S. and C. America, and now moving into N. America. There are nine genera, with 21 species.

Dasyproctidae (agoutis, pacas; order Rodentia, suborder Hystricomorpha) Family of rodents with claws (forelimb four, hind limb three) resembling hoofs. They are long-legged, with a running gait. The tail is short or absent. Cheek teeth are hypsodont. These rodents are distributed throughout the northern part of S. America and C. America. There are four genera, with 11 species.

Dasyuridae (marsupial carnivores, rats, mice, native cat, ant-eater; order Marsupialia, superfamily Dasyuroidea) Family of mainly nocturnal animals, showing convergence with placental carnivores, especially in their dentition. The incisors are small and pointed, the canines large, the cheek teeth modified for shearing (and resembling carnassials). Dasyurids are distributed widely from New Guinea to Tasmania, although *Sarcophilus harrisi* (Tasmanian devil), a nocturnal predator and scavenger, is now confined to Tasmania. There are about 20 genera, with at least 50 species.

Dasyuroidea (infraclass Metatheria, order Marsupialia) Superfamily comprising the families Dasyuridae, Notoryctidae, Thylacinidae, and Myrmecobiidae; marsupials in which the marsupium, if present, opens toward the rear. The second and third digits of the hind feet are didactylous; the first is often vestigial or absent, and if present is clawless and not opposable. There are three or more pairs of incisors of equal size in upper and lower jaws.

date palm (*Phoenix dactylifera*) *See Phoenix*.

dating methods (geol.) During the last century geologists constructed a relative time-scale based on correlation of palaeontological and stratigraphical data. Depositional rates of sediments have also been employed as a dating method, but only recently has absolute dating been made possible, through the use of radioactive isotopes: the method is termed geochronometry. Of the various methods the last is obviously the most precise but fossils and lithologies do enable the geologist to give an approximate age in field studies. *See also* radiometric dating.

Datiscaceae Small, disparate family of herbs and trees in which the leaves are large, palmately-nerved, and without stipules. The flowers are unisexual, the ovary inferior, and placentation parietal. The fruit is a capsule, with many seeds. The family is perhaps related to the Begoniaceae and Cucurbitaceae. There are three genera, with four species: *Datisca* species, herbs of America and Asia, and *Octomeles sumatrana* and *Tetrameles nudiflora*, trees of Indo-Malaysia.

Datura (family Solanaceae, tribe Datureae) Genus of robust annual herbs which grow up to 1.5 m in height, and often have purplish stems. The leaves are alternate, but often opposite towards the top of the stem; they have petioles, and are generally glabrous. The solitary flowers are held in the axils, with the flower stems elongating at the fruiting stage. The calyx is angular and sharply toothed. The five petals are fused into a funnel, and are white or purple. The five stamens are enclosed. The ovary has four locules and forms a four-valved, spiny capsule. Several species are used medicinally and others are poisonous weeds. *D. stramonium*, the common thorn-apple, has been spread from America to many parts of the world, including Britain and Australia. There are 10 species in this genus, which is one of the two genera within the tribe. They are found in tropical and temperate regions of America and Australia, and many have now become widespread.

Daubentoniidae (aye-ayes; order Primates, suborder Prosimii, infra-order Lemuriformes) Family of nocturnal primates in which all the digits except the big toe have claws rather than nails, and in which the third digit of the hand is elongated. There is one pair of incisors, which are enlarged, chisel-like, reminiscent of rodent incisors, and used for gnawing. The ears are large and movable. Aye-ayes are found only in Madagascar. There is one genus (*Daubentonia*), with two species.

Daucus (carrot; family Umbelliferae) Genus of plants having stout, spiny ridges on the fruits; and tap roots which, in cultivated forms, become a fleshy, nutritious vegetable. There are about 60 species found in northern temperate regions.

daughter *See* radioactive decay.

daughter cells The two cells that result from the division of a single cell, usually by mitosis. *See also* daughter nuclei.

daughter nuclei The two nuclei that result from the division of a single nucleus, usually by mitosis. *See also* daughter cells.

Deinotheriidae (order Proboscidea, suborder Deinotherioidea) Extinct family of what are often called 'hoe-tuskers' because they had large, down-turned tusks on their lower jaws. These probiscideans lived from the Miocene until the end of the Pleistocene, when they disappeared in a wave of extinctions which affected the larger mammals of all continents.

Deinotherioidea (superorder Paenungulata, order Proboscidea) Extinct suborder of elephant-like animals which lived in the Miocene and Pliocene of Eurasia and survived, in tropical Africa, into the Pleistocene. Early forms were smaller, but later forms larger, than modern elephants. The proboscis was long; upper tusks were absent; the lower tusks were large, curving downward and sometimes to the rear. The suborder is considered to be divergent from the evolutionary path leading to modern elephants.

Delesseriaceae (order Ceramiales) Family of red seaweeds in which the thallus is delicate, membranaceous, and brilliant red. In some genera there is a distinctive pattern of 'midribs' and 'veins' resembling those of higher plants, although distinct in structure and function. These seaweeds are found attached to rocks or to other seaweeds, typically near or below low-water mark, or in shady pools.

deletion The loss of a chromosomal segment from a chromosome set. The size of the deletion may vary from a single nucleotide to sections containing several genes. If the deletion is from the end of a chromosome, it is called 'terminal'; if it is from elsewhere, it is termed 'intercalary'.

Delhi boil (oriental sore) Ulcerating skin lesion caused by infection with the protozoon *Leishmania tropica*. The parasite is transmitted by sandflies (*Phlebotomus*). Delhi boil occurs in oriental and tropical regions.

Delichon (martins; family Hirundinidae) Genus of hirundines with dark steel-blue upper-parts, white under-parts, a white rump, and a slightly forked or square tail. Martins are found in open country, near habitation, cliffs, and river valleys, feeding on insects and nesting on cliffs or buildings. *D. urbica* (house martin) is particularly associated with habitation. There are three species, found in the Palaearctic, W. Africa, S. and SE Asia, and Indonesia.

Delichon urbica (house martin) *See Delichon.*

dell Shallow, stream-free valley whose long profile may be irregular. Typically it is found in present or former periglacial areas, and is due to erosion by surface run-off over a frozen subsoil. Local subsidence due to the thawing of ground ice may be a contributory factor.

Delonix (family Leguminosae, subfamily Caesalpinioideae) Genus of trees which includes *D. regia* ('flame of the forest' or flamboyant), one of the tropics' loveliest flowering trees, known in the wild from just one specimen. There are three species, occurring in tropical Africa and Madagascar.

Delphacidae (plant hoppers; order Hemiptera, suborder Homoptera) Family of homopterans in which the hind tibia is triangular in section and bears a mobile spur at the apex. There are thousands of species, distributed throughout the world, some of which are serious pests of sugar-cane and rice.

Delphinidae (order Cetacea, suborder Odontoceti, superfamily Delphinoidea) Family comprising the dolphins, killer whales, and pilot whales. They are relatively small cetaceans (1.5–9.4 m). The dorsal fin is prominent except in Lissodelphinae (the subfamily of southern-right dolphins) in which it is absent. The first two or four, or all, cervical vertebrae are fused. Delphinids are distributed throughout all oceans. *Tursiops truncatus* (the bottle-nosed dolphin) is distributed widely in the N. Atlantic, and in Britain is prone to stranding. *Globicephala melaena* (pilot whale) is also prone to stranding, sometimes in large schools. The family comprises about 14 genera, and about 32 species.

Delphinium (family Ranunculaceae) Genus of annual or perennial herbs, with erect stocks or tap roots; palmately lobed leaves; and irregular flowers in racemes, comprising five petaloid sepals (the posterior one with a spur), four petal nectaries, many stamens, and 1–3 follicles which form the fruit. Many *Delphinium* species are cultivated for their attractive flowers. There are about 200 species, found in the northern hemisphere.

Delphinoidea (order Cetacea, suborder Odontoceti) Superfamily comprising the families Delphinidae, Phocaenidae, Stenidae, and Monodontidae, a large group of small cetaceans with teeth in both jaws, and usually a prominent dorsal fin. Most are active predators, but *Sousa* (the white or long-backed dolphin), of the coasts and rivers of the Old World tropics, is herbivorous.

Delphinus (dolphin) *See* Delphinidae.

delta Sedimentary environment formed where a sediment-laden current enters an open body of water, at which point there is a reduction in the velocity of the current. This results in rapid deposition of the suspended material, which forms a lobate body of sediment, for example at the mouth of a river where the river discharges into the sea or a lake. There is a characteristic coarsening upwards of sediments, clearly seen in the Mississippi and Nile Deltas. A river provides the sediments to form a delta; but the shape and nature of a delta is controlled by a variety of factors including climate, water discharge, sediment load, rate of subsidence of the sea or lake floor, and the nature of the river-mouth processes. One classification of delta types, based on variations in transport patterns on the delta, subdivides deltas into three classes: (a) river-dominated, e.g. the Mississippi and Po; (b) wave-dominated, e.g. the Rhône and Nile; (c) tide-dominated, e.g. the Ganges and Mekong.

Deltatheridium Small, probably carnivorous mammal from the Upper Cretaceous. It was once thought to be an insectivore, but the possession of certain dental characters indicate that it was a likely ancestor or sister group to the creodonts and Carnivora.

delthyrium Subtriangular opening or slit-like notch beneath the apex of the pedicle valve of some brachiopods, for the passage of the pedicle.

deltidial plate Calcareous deposit at the side of the delthyrium which serves to constrict or close the opening.

deme Spatially discrete interbreeding group of organisms with definable genetic or cytological characters, i.e. a subpopulation of a species. There is very restricted genetic exchange, if any, with other demes, although demes are usually contiguous with one another, unlike subspecies or races which are generally isolated by some geographical or habitat barrier. All possible male and female pairings within a deme have an equal chance of forming, for one breeding season at least. Populations which fulfil only one of the two key criteria, i.e. very occasional or no cross-breeding and free pairing, are also referred to as demes by some authors.

demersal Applied to fish that live close to the sea-floor, e.g. the cod (*Gadus morrhua*), the hake (*Merluccius merluccius*), and the saithe (*Pollachius virens*).

demesne Land that is worked or occupied by its owner.

demibranch V-shaped structure of gills that is common to pelecypods. It consists of two lamellae containing gill filaments; inner and outer demibranchs are joined by the ctenidial axis, giving the gill a typical W-shape.

demoiselle *See Calopteryx virgo*.

Demospongea *See* Demospongiae.

Demospongiae (Demospongea; phylum Porifera) Class of sponges which occur in both marine and freshwater environments. They have a leucon body structure. Both siliceous spicules and organic fibres may form a skeleton, but primitive types may lack skeletal support. This is the largest group of sponges and it first appeared in the Cambrian.

den Subapical portion of the springing organ (furca or furcula) of Collembola. A pair of dens arises from the basal manubrium and each den terminates in lamellate mucrones.

denaturation Reversible or irreversible alterations in the biological activity of proteins or nucleic acids, brought about by changes in structure other than the breaking of the primary bonds between amino acids or nucleotides in the chain. This may be accomplished by changes of solvent, pH, or temperature, or through the physical abuse of the molecules.

dendrite Multiply-branched process, arising from the cell body of a neuron, that receives impulses from other neurons.

dendritic drainage *See* drainage.

Dendroaspis (mambas; order Squamata, suborder Serpentes (Ophidia), family Elapidae) Genus of venomous African snakes. It includes the terrestrial black mamba, which may reach 4.25 m in length: this is agile, with a recorded speed of 11 km/h across country. Arboreal green mambas are up to 2.7 m long: they eat mainly small birds and mammals.

Dendrobates (arrow-poison frogs; order Anura (Salientia), family Ranidae) Genus of frogs from tropical S. America, notable for their extremely vivid warning colours and highly poisonous skin. The skin secretes batrachotoxin, the most powerful known vertebrate animal venom.

Dendrobium (family Orchidaceae) Genus of orchids, some of which are cultivated, popular, and sold throughout the world. There are more than 1000 species, found in Asia, New Guinea and the SW Pacific; and 55 species are endemic to Australia, which is where the genus is best represented, distribution being concentrated in the northern states.

Dendrocalamus (family Gramineae, subfamily Bambusoideae) Genus of giant bamboos in which the fruit is a nut. *D. giganteus* is the biggest known bamboo. There are 20 species, occurring from China to Malesia.

Dendroceratida (class Demospongiae, subclass Ceractinomorpha) Order of sponges which lack spicules. Some also lack skeletons composed of organic fibres. When fibres do occur they emanate from a basal sponge plate in a branching fashion. Generally they do not incorporate detritus.

Dendrochirotacea (class Holothuroidea) Subclass of sea-cucumbers, characterized by the ability to retract the anterior part of the body wall within the oral aperture by use of muscles connecting it to a ring of calcite plates surrounding the oesophagus. The fossil record dates back to the Ordovician.

Dendrochirotida (subclass Dendrochirotacea) Order of holothuroids in which the tentacles are enlarged to form branching, tree-like structures, ciliated and adapted to collect food from the plankton.

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Dendrocopos *See Picoides*.

Dendrocygna (whistling ducks; family Anatidae) Genus of small, goose-like ducks with long necks,

Deinotheriidae (order Proboscidea, suborder Deinotherioidea) Extinct family of what are often called 'hoe-tuskers' because they had large, down-turned tusks on their lower jaws. These probiscideans lived from the Miocene until the end of the Pleistocene, when they disappeared in a wave of extinctions which affected the larger mammals of all continents.

Deinotherioidea (superorder Paenungulata, order Proboscidea) Extinct suborder of elephant-like animals which lived in the Miocene and Pliocene of Eurasia and survived, in tropical Africa, into the Pleistocene. Early forms were smaller, but later forms larger, than modern elephants. The proboscis was long; upper tusks were absent; the lower tusks were large, curving downward and sometimes to the rear. The suborder is considered to be divergent from the evolutionary path leading to modern elephants.

Delesseriaceae (order Ceramiales) Family of red seaweeds in which the thallus is delicate, membranaceous, and brilliant red. In some genera there is a distinctive pattern of 'midribs' and 'veins' resembling those of higher plants, although distinct in structure and function. These seaweeds are found attached to rocks or to other seaweeds, typically near or below low-water mark, or in shady pools.

deletion The loss of a chromosomal segment from a chromosome set. The size of the deletion may vary from a single nucleotide to sections containing several genes. If the deletion is from the end of a chromosome, it is called 'terminal'; if it is from elsewhere, it is termed 'intercalary'.

Delhi boil (oriental sore) Ulcerating skin lesion caused by infection with the protozoon *Leishmania tropica*. The parasite is transmitted by sandflies (*Phlebotomus*). Delhi boil occurs in oriental and tropical regions.

Delichon (martins; family Hirundinidae) Genus of hirundines with dark steel-blue upper-parts, white under-parts, a white rump, and a slightly forked or square tail. Martins are found in open country, near habitation, cliffs, and river valleys, feeding on insects and nesting on cliffs or buildings. *D. urbica* (house martin) is particularly associated with habitation. There are three species, found in the Palaearctic, W. Africa, S. and SE Asia, and Indonesia.

Delichon urbica (house martin) *See Delichon*.

dell Shallow, stream-free valley whose long profile may be irregular. Typically it is found in present or former periglacial areas, and is due to erosion by surface run-off over a frozen subsoil. Local subsidence due to the thawing of ground ice may be a contributory factor.

Delonix (family Leguminosae, subfamily Caesalpinioideae) Genus of trees which includes *D. regia* ('flame of the forest' or flamboyant), one of the tropics' loveliest flowering trees, known in the wild from just one specimen. There are three species, occurring in tropical Africa and Madagascar.

Delphacidae (plant hoppers; order Hemiptera, suborder Homoptera) Family of homopterans in which the hind tibia is triangular in section and bears a mobile spur at the apex. There are thousands of species, distributed throughout the world, some of which are serious pests of sugar-cane and rice.

Delphinidae (order Cetacea, suborder Odontoceti, superfamily Delphinoidea) Family comprising the dolphins, killer whales, and pilot whales. They are relatively small cetaceans (1.5–9.4 m). The dorsal fin is prominent except in Lissodelphinae (the subfamily of southern-right dolphins) in which it is absent. The first two or four, or all, cervical vertebrae are fused. Delphinids are distributed throughout all oceans. *Tursiops truncatus* (the bottle-nosed dolphin) is distributed widely in the N. Atlantic, and in Britain is prone to stranding. *Globicephala melaena* (pilot whale) is also prone to stranding, sometimes in large schools. The family comprises about 14 genera, and about 32 species.

Delphinium (family Ranunculaceae) Genus of annual or perennial herbs, with erect stocks or tap roots; palmately lobed leaves; and irregular flowers in racemes, comprising five petaloid sepals (the posterior one with a spur), four petal nectaries, many stamens, and 1–3 follicles which form the fruit. Many *Delphinium* species are cultivated for their attractive flowers. There are about 200 species, found in the northern hemisphere.

Delphinoidea (order Cetacea, suborder Odontoceti) Superfamily comprising the families Delphinidae, Phocaenidae, Stenidae, and Monodontidae, a large group of small cetaceans with teeth in both jaws, and usually a prominent dorsal fin. Most are active predators, but *Sousa* (the white or long-backed dolphin), of the coasts and rivers of the Old World tropics, is herbivorous.

Delphinus (dolphin) *See* Delphinidae.

delta Sedimentary environment formed where a sediment-laden current enters an open body of water, at which point there is a reduction in the velocity of the current. This results in rapid deposition of the suspended material, which forms a lobate body of sediment, for example at the mouth of a river where the river discharges into the sea or a lake. There is a characteristic coarsening upwards of sediments, clearly seen in the Mississippi and Nile Deltas. A river provides the sediments to form a delta; but the shape and nature of a delta is controlled by a variety of factors including climate, water discharge, sediment load, rate of subsidence of the sea or lake floor, and the nature of the river-mouth processes. One classification of delta types, based on variations in transport patterns on the delta, subdivides deltas into three classes: (a) river-dominated, e.g. the Mississippi and Po; (b) wave-dominated, e.g. the Rhône and Nile; (c) tide-dominated, e.g. the Ganges and Mekong.

Deltatheridium Small, probably carnivorous mammal from the Upper Cretaceous. It was once thought to be an insectivore, but the possession of certain dental characters indicate that it was a likely ancestor or sister group to the creodonts and Carnivora.

delthyrium Subtriangular opening or slit-like notch beneath the apex of the pedicle valve of some brachiopods, for the passage of the pedicle.

deltidial plate Calcareous deposit at the side of the delthyrium which serves to constrict or close the opening.

deme Spatially discrete interbreeding group of organisms with definable genetic or cytological characters, i.e. a subpopulation of a species. There is very restricted genetic exchange, if any, with other demes, although demes are usually contiguous with one another, unlike subspecies or races which are generally isolated by some geographical or habitat barrier. All possible male and female pairings within a deme have an equal chance of forming, for one breeding season at least. Populations which fulfil only one of the two key criteria, i.e. very occasional or no cross-breeding and free pairing, are also referred to as demes by some authors.

demersal Applied to fish that live close to the sea-floor, e.g. the cod (*Gadus morrhua*), the hake (*Merluccius merluccius*), and the saithe (*Pollachius virens*).

demesne Land that is worked or occupied by its owner.

demibranch V-shaped structure of gills that is common to pelecypods. It consists of two lamellae containing gill filaments; inner and outer demibranchs are joined by the ctenidial axis, giving the gill a typical W-shape.

demoiselle *See Calopteryx virgo*.

Demospongea *See* Demospongiae.

Demospongiae (Demospongea; phylum Porifera) Class of sponges which occur in both marine and freshwater environments. They have a leucon body structure. Both siliceous spicules and organic fibres may form a skeleton, but primitive types may lack skeletal support. This is the largest group of sponges and it first appeared in the Cambrian.

den Subapical portion of the springing organ (furca or furcula) of Collembola. A pair of dens arises from the basal manubrium and each den terminates in lamellate mucrones.

denaturation Reversible or irreversible alterations in the biological activity of proteins or nucleic acids, brought about by changes in structure other than the breaking of the primary bonds between amino acids or nucleotides in the chain. This may be accomplished by changes of solvent, pH, or temperature, or through the physical abuse of the molecules.

dendrite Multiply-branched process, arising from the cell body of a neuron, that receives impulses from other neurons.

dendritic drainage *See* drainage.

Dendroaspis (mambas; order Squamata, suborder Serpentes (Ophidia), family Elapidae) Genus of venomous African snakes. It includes the terrestrial black mamba, which may reach 4.25 m in length: this is agile, with a recorded speed of 11 km/h across country. Arboreal green mambas are up to 2.7 m long: they eat mainly small birds and mammals.

Dendrobates (arrow-poison frogs; order Anura (Salientia), family Ranidae) Genus of frogs from tropical S. America, notable for their extremely vivid warning colours and highly poisonous skin. The skin secretes batrachotoxin, the most powerful known vertebrate animal venom.

Dendrobium (family Orchidaceae) Genus of orchids, some of which are cultivated, popular, and sold throughout the world. There are more than 1000 species, found in Asia, New Guinea and the SW Pacific; and 55 species are endemic to Australia, which is where the genus is best represented, distribution being concentrated in the northern states.

Dendrocalamus (family Gramineae, subfamily Bambusoideae) Genus of giant bamboos in which the fruit is a nut. *D. giganteus* is the biggest known bamboo. There are 20 species, occurring from China to Malesia.

Dendroceratida (class Demospongiae, subclass Ceractinomorpha) Order of sponges which lack spicules. Some also lack skeletons composed of organic fibres. When fibres do occur they emanate from a basal sponge plate in a branching fashion. Generally they do not incorporate detritus.

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Dendrocopos *See Picoides*.

Dendrocygna (whistling ducks; family Anatidae) Genus of small, goose-like ducks with long necks,

large feet, and a high narrow bill. Their wings are round with no specula. They are partially nocturnal and inhabit marshes and ponds, feeding mainly on vegetable matter and nesting in tree cavities or reeds. There are eight species, found in southern USA, C. and S. America, Africa, from S. Asia to Australia, and some Pacific Ocean islands.

dendroecology Branch of dendrochronology dealing with the relationships between patterns in dated tree-ring series and all the ecological factors that may influence those patterns. As well as climate, it considers competition, predation, etc.

dendrogeomorphology The use of dated tree-ring series to study land-forms and geomorphological processes.

dendrograph Instrument that provides a continuous record of the circumference of a tree stem. It is especially useful for recording diurnal changes in stem size related to differences in hydration. There are several designs.

dendrohydrology The use of dated tree-ring series to study hydrological questions, especially relating to the periodicity of river flow and flooding.

Dendroica (warblers; family Parulidae) Genus of small, often brightly coloured warblers. They are arboreal, feeding on insects and berries, nesting in trees and bushes. Most are migratory. There are 27 species, found in N., C., and S. America, and the West Indies. *D. petrechia* (yellow warbler) exists in a number of distinct racial forms and throughout the Americas, while *D. kirtlandii* (Kirtland's warbler) has a breeding range confined to a small area of jack pine in Michigan, USA.

Dendroica kirtlandii (Kirtland's warbler) *See Dendroica*.

Dendroica petrechia (yellow warbler) *See Dendroica*.

dendroid colony 1 In corals, a colony formed by the irregular branching of corallites. The individual corallites are somewhat separated from one another, but may be joined by connecting tubules. 2 In graptolites, a bushy colony formed by irregular branching of the stipes.

Dendroidea (dendroid graptolites; class Graptolithina) Extinct order of sessile forms, attached by the apex of the sicula. Stipes made up of polymorphic thecae are produced from a stolon in regularly alternating triads of autotheca, bitheca, and stolotheca. A rhabdosome is usually dendroid and is developed by dichotomous or irregular branching, often with anastomosis or dissepimental connections between adjacent stipes. Dendroidea are known from the Middle Cambrian to Lower Carboniferous. The order contains six families, with about 30 genera.

dendroid graptolites *See* Dendroidea.

dendrometer Instrument for measuring the size of tree stems. Most commonly it consists of a thin metal band with a vernier scale: it allows precise measurement of the stem circumference.

Dendrophthoe (family Loranthaceae) Genus of plants which are heterotrophic, stem hemiparasites. There are 30 species, found in Africa, Asia, and tropical Australia.

Dendrophylliina (order Madreporaria) Suborder of solitary or colonial corals which appeared first in the Upper Cretaceous. They are like the related suborder Fungiina, but have laminated septa and a wall formed of synapticulae. The suborder contains 24 genera, in one family.

dengue Acute human disease which occurs in tropical and subtropical regions. Symptoms include fever, and pains in the head, limbs, and back. It is caused by a flavivirus, and transmitted by mosquitoes, principally *Aëdes aegypti*.

denitrification The conversion of nitrate or nitrite to gaseous products, chiefly nitrogen (N_2), by certain types of bacteria (called 'denitrifying bacteria').

denitrifying bacteria Soil bacteria which reduce nitrates to nitrites and ultimately to nitrous oxide or nitrogen, under anaerobic conditions. *See also* denitrification.

Dennstaedtiaceae Family of ferns in which the sori are marginal, and are either continuous or form discrete units within tubular indusia. They are intermediate in sorus type between the wholly gradate sorus of Dicksoniaceae and the wholly mixed type of Davalliaceae. There are about 20 genera, with a worldwide distribution, although they are mainly tropical.

density current Current that is produced by differences in density. Where a flow of sea-water has a greater density than that surrounding it, the more dense water will dive beneath the less dense water. Density of sea-water is affected by temperature, salinity, and the content of suspended sediment. A turbidity current is a gravity-controlled density current, in which the density contrast is due to the high suspended-sediment content.

density dependence Regulation of the size of a population by mechanisms themselves controlled by the size of that population, i.e. environmental-resistance factors, whose effectiveness increases as population size increases. *See also* S-shaped growth curve.

density–frequency–dominance (DFD measure) Combined abundance estimate used in the early N. American ordination schemes developed by G. Cottam (1949), and J. T. Curtis and R. P. McIntosh (1950, 1951), usually expressed as relative values. Relative density is the number of a given species expressed as a percentage of all species present. Relative frequency is the frequency of a given species expressed as a percentage of the sum of frequency values for all species present. Relative dominance is the basal area of a given species expressed as a percentage of the total basal area of all species present. These three measures are summed to give the importance value, which may lie between 0 and 300.

density independence *See* J-shaped growth curve.

density measure (ecoe) Estimate of the abundance of a particular plant species, as the number of

individuals per unit area. In practice, problems arise with those plants, including many grasses, for which identification of single individuals is difficult.

dental caries Tooth decay. Dental caries are believed to be at least partly due to the corrosive effects of products of *Streptococcus mutans*, a bacterium which is normally present in the mouth and which adheres specifically to teeth.

dental plaque Layer of material that is present normally on teeth. Plaque consists of a variety of micro-organisms in a matrix consisting of bacterial products and salivary substances. Bacteria present in plaque (especially *Streptococcus mutans*) appear to be largely responsible for dental caries.

dentary Anterior bone of the lower jaw which bears the teeth. In mammals it forms the whole of the lower jaw.

dentate Toothed or serrated.

denticle In many fish, a scale composed of dentine, with a pulp cavity, which resembles a tooth. In Elasmobranchii denticles cover the entire body. *See also* placoid scale.

denticulate Having very small teeth or serrations.

dentine Bone-like substance, lacking cell bodies and consisting mainly of calcium phosphate in a fibrous matrix.

denudation From the Latin *denudare*, to strip bare, and involving the processes of weathering, transportation, and erosion.

denudation chronology Branch of land-form studies that deals with the historical development of landscapes, especially during pre-Quaternary time. Evidence for developmental stages is provided by studies of erosion surfaces and their mantling deposits, drainage patterns, stream long-profiles, and geological structures.

deoxyribonucleic acid (DNA) Nucleic acid, characterized by the presence of the sugar deoxyribose, the pyrimidine bases cytosine and thymine, and the purine bases adenine and guanine. It is the genetic material of organisms, its sequence of paired bases constituting the genetic code. *See also* Watson–Crick model.

depasture Put domestic animals out to graze on common or forest land.

deplasmolysis Entrance of water into a plasmolysed plant cell, causing the cell membrane to return to the cell wall.

deposit gauge Device for collecting solid and liquid atmospheric pollutants.

depressed body of fish Body form, found in some fish, that appears flattened from above. Such fish tend to have the flat belly, widely-spaced pectoral fins, and eyes on top of the head indicative of bottom-dwelling species, e.g. the flatheads (Platycephalidae). Fish that have bodies that appear flattened from side to side are said to have a compressed body form.

depression Enclosed area of low pressure shown by a pattern of pressure distribution. Depressions are also described as cyclones, or cyclonic systems, and have a characteristic pattern of wind circulation (anticlockwise around low pressure areas in the northern hemisphere). Mid-latitude depressions are associated with the convergence of polar and tropical air masses along a frontal zone: this commonly becomes deformed, and each air mass in turn advances over parts near (especially south of) the depression path, bringing first a warm and then a cold front.

deranged drainage *See* drainage.

Derichthyidae (longneck eels; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of deep-water, tropical eels, 30 cm in length, with a scaleless body and large eyes. They are found in the Atlantic and Pacific.

derived (evol.) *See* apomorph.

dermal denticles *See* placoid-scale.

Dermaptera (earwigs; class Insecta) Order of elongate, flattened, exopterygote insects whose major diagnostic features include cerci which are modified as a pair of forceps on the end of the mobile, telescopic abdomen; and forewings which are reduced as short tegmina, beneath which the large, membranaceous hindwings are intricately folded, although many species are wingless. Earwigs are found in crevices, particularly among plant debris, and are nocturnal. They feed on living and dead plant and animal material. Earwigs are interesting biologically in that they show parental care of offspring. Some species are pests, damaging flowers and fruit. About 1200 species have been described, most of them occurring in the tropics and warm-temperate regions.

Dermatemydidae (Tabasco turtles; order Chelonia (Testudines), suborder Cryptodira) Family of turtles in which the shell is smooth and fully ossified. They are nocturnal, bottom-dwelling turtles that seldom emerge from the water. Eggs are laid on the river bank. These turtles are herbivorous on water plants. The family consists of a single species, *Dermatemys mawi*, found in coastal rivers of Mexico and Guatemala.

Dermatemys mawi (Tabasco turtle) *See* Dermatemydidae.

Dermatobia hominis (human warble fly) *See* Oestridae.

Dermatophilaceae (order Actinomycetales) Family of aerobic, mycelium-forming bacteria, in which the filaments divide transversely and longitudinally to form masses of cells that bear flagella and are motile. Some species are found in soil, others infect skin of humans and other animals.

dermatophyte Fungus that lives parasitically on skin.

Dermestes lardarius (bacon beetle, larder beetle) *See* Dermestidae.

Dermestidae (skin beetles, hide beetles, tallow beetles, museum beetles; class Insecta, order Coleoptera) Family of black or brown, small beetles, often with a pattern of fine hairs or scales,

in which the pronotum is strongly narrowed toward the head, and the antennae are clubbed. Dermestidae occur in flowers, feeding on pollen. The larvae are subcylindrical, and covered with long hair. *Anthrenus* larvae ('woolly bears' or 'carpet beetles') attack woollen carpets, furs, and dried museum specimens. *Dermestes lardarius* larvae ('bacon beetles' or 'larder beetles') attack furs, hides, and stored meat and cheese. There are 731 species, occurring worldwide.

Dermochelidae (leathery turtle, leatherback; order Chelonia (Testudines), suborder Cryptodira) Family which contains one species, *Dermochelys coriacea*, the largest marine turtle (up to 600 kg and 2 m long). The shell is not fused to the ribs or vertebrae, being reduced to dermal ossicles in a thick, leathery skin. The carapace is ridged, the flippers clawless. It occurs in all warm oceans.

Dermoptera (colugo, 'flying lemur'; cohort Unguiculata, order Insectivora) Suborder (sometimes regarded as an order) which comprises the family Cynocephalidae and a number of extinct forms. They are insectivores possessing a patagium, and are the most highly developed of all mammalian gliding forms. Although unrelated to the bats, they are probably, like them, of insectivore ancestry. The fossil record for the group is poor, but what seem to have been early representatives are known from the late Palaeocene and Lower Eocene of N. America.

Derris (family Leguminosae, subfamily Papilionatae) Genus mainly of climbers, some of which are important as the source of fish poisons and a cheap, safe insecticide. There are 70 species occurring throughout the tropics.

Derwent whitebait (*Lovettia sealii*) *See* Aplochitonidae.

desert Term which is difficult to define: deserts may be thought of in terms of biomes in which the average precipitation is less than 250 mm/yr, and typically very erratic. Plants and animals are either absent or sparsely distributed, and are adapted to long droughts or to a lack of access to free water.

desert biome The characteristic biotic community of warm, arid regions, generally defined as areas with rainfall of less than 250 mm/yr. Characteristically, such areas have high evaporation rates and a large diurnal temperature range. Organisms commonly show adaptations to drought and heat, e.g. water storage in succulents such as cacti, and the frequent use among desert mammals of the burrowing habit. A high percentage of annual species is characteristic of desert flora.

desertification Process of desert expansion or formation, which may occur as a direct consequence of climatic change (e.g. shifts in the location of the major planetary pressure and wind systems), as the result of poor land-use policy (e.g. overgrazing), or due to some complex interaction of these factors (e.g. overgrazing leading to albedo change, favouring climatic change in the form of increased dryness). The classic example of desertification is seen in the Sahelian zone of Africa.

desert locust (*Schistocerca gregaria*) *See* locust.

desert mining bees *See* Fideliidae.

desert pavement Thin coverings of gravel and stones on many desert areas, left after erosion by wind and water has removed the finer soil materials.

desert varnish Dark surface veneer of iron and manganese oxides which coats exposed rocks in hot deserts. It results from the surface precipitation of minerals released by chemical weathering and then drawn upwards in solution by capillary movement.

Desfontainea (family Loganiaceae) Genus of bushes, including *D. spinosa*, with small, holly-like leaves and scarlet, tubular flowers. It is the national flower of Bolivia, and is sometimes cultivated in Britain. There are three species, occurring in the Andes.

desiccation Long-term loss of water associated with regional climatic change.

desman *See* Talpidae.

desmid Alga belonging to the family Desmidaceae.

Desmidaceae (order Zygnematales) Family of green algae which are basically unicellular but have two distinct halves, or 'semi-cells'. The cells may be solitary or may form irregular or filamentous colonies. The cells may vary in shape within a single species, making identification and classification difficult. They are found in freshwater habitats and are usually indicators of clean (unpolluted) water.

desmodont Applied to a type of hinge condition found in certain pelecypods in which the teeth are very small or lacking, and ridges may have replaced them. The ligament may be supported by a chondrophore.

Desmodontidae (vampire bats; order Chiroptera, suborder Microchiroptera) Family of bats (sometimes included in the Phyllostomatidae) in which the incisors are adapted for piercing, and the digestive system is modified for a diet consisting exclusively of blood. The nose has a fleshy pad; the ears are well separated; the tail is absent. The limbs are sufficiently strong to support the weight of the animal on the ground, enabling it to run and jump with agility. Vampire bats are distributed throughout tropical America and subtropical S. America. There are three genera (*Desmodus*, *Diaemus*, and *Diphylla*), with three species.

desmognathous In birds, a structurally distinct form of the palate, in which the maxillopalatine bones are fused. It is found in Anseriformes, Pelecaniformes, Psittaciformes, and some other groups.

Desmoncos (family Palmae) Genus of climbing palms in which all the parts are very spiny. The leaves are pinnate, the apical leaflets often modified as tough reflexed hooks. There are 64 species, occurring in the New World, where they are the counterpart of the rattans of the Old World.

desmosome Oval or circular junction between two cells where their respective plasma membranes run parallel to one another 30–50 nm apart. Immediately within each membrane there is a plaque of

electron-dense material and behind this a less dense area of microfilaments. The space between the membranes contains a glycoprotein. The function of such a junction appears to be that of mechanical attachment.

Desmostylia Extinct order of subungulates known from Miocene and Pliocene rocks. They resembled the hippopotamus in their general proportions and probably followed, like the hippopotamus, an amphibious way of life, though in shallow coastal waters. It seems that they shared a common descent with the sirenians and proboscideans, from early African subungulates.

Desmostylus hesperus Species of subungulate mammals from the mid-Tertiary (Upper Miocene to Lower Pliocene) of western N. America and E. Asia. *Desmostylus* lived in shallow coastal waters and was an early sirenian-like animal, although the body was large, of hippopotamus size, with massive limbs. The skull was elongate, and there were 'tusks' on both upper and lower jaws.

destroying angel Common name for the deadly-poisonous fruit body of *Amanita virosa*. It is mushroom-like: white, with white gills and a shaggy stipe. It is found on the ground in broad-leaved woods in late summer and autumn.

destructive wave Relatively high-energy shallow-water wave that causes degradation of a beach by moving more material seawards than landwards, thus having a net erosional effect on the adjacent beach. It is characterized by high frequency, which implies that the swash is impeded by the backwash from the preceding wave. The backwash is more effective than the swash in moving material, and waves having this character are usually steep and associated with onshore winds. The erosional effect is also enhanced by the near-vertical plunge on breaking. It is favoured by a relatively steeply sloping offshore zone.

Desulfovibrio Genus of bacteria which is not assigned to a taxonomic family. The cells are Gram-negative, rod-shaped, curved, and motile with flagella at one end. They are chemo-organotrophic and can grow only in the absence of air. Energy is obtained by the oxidization of inorganic compounds with the concomitant reduction of sulphate (and other inorganic sulphur compounds) to sulphide. *Desulfovibrio* species are found in aquatic environments, waterlogged soils, etc.; they produce hydrogen sulphide (which smells like rotten eggs), which is responsible for the consequent blackening of mud (due to the formation of black metal sulphides) in such habitats.

detorsion The untwisting of the viscera during development in certain Gastropoda. *Compare* torsion.

detoxication *See* detoxification.

detoxification (detoxication) Removal by an organism of toxic substances, by converting them to a form that is less toxic or that can be disposed of more readily. Toxic chemicals in plants are frequently converted to glycosides or to amino-acid conjugates, or may be oxidized and perhaps then conjugated.

detrital pathway (detritus food-chain) Most simply, a food-chain in which the living primary producers (green plants) are not consumed by grazing herbivores, but eventually form litter (detritus) on which decomposers (micro-organisms) and detritivores feed, with subsequent energy transfer to various levels of carnivore. Detritus from organisms at higher trophic levels than green plants may also form the basis for a detrital pathway, but the key distinction between this and a grazing pathway lies in the fate of the primary producers.

detritivore Heterotrophic animal that feeds on dead material, e.g. leaf litter. The dead material most typically is of plant origin, but may include the dead remains of small animals. Since this material may also be digested by decomposer organisms (fungi and bacteria) and forms the habitat for other organisms (e.g. nematode worms and small insects), these too will form part of the typical detritivore diet. Animals (e.g. hyena) that feed mainly on other dead animals, or that feed mainly on the products (exuviae, e.g. dung), of larger animals, are termed scavengers. *See also* food-chain; *compare* carnivore; and herbivore.

detritus agriculture The planned production of detritus as a source of food, e.g. silage production. Detritus agriculture is thought by some workers to have great potential as an alternative to harvesting the products of the grazing food-chain (i.e. animal products). They argue that the economic and environmental costs of microbial conversion of the detritus to palatable human food would be less than the costs of pest and disease control, etc.

detritus feeder *See* detritivore.

detritus food-chain *See* detrital pathway.

Deuteromycotina (Fungi Imperfecti; division Eumycota) Subdivision that includes an assorted assemblage of imperfect fungi in which perfect states are either unknown or classified in other subdivisions. The subdivision and its constituent groups are convenient categories and not true phylogenetic taxa.

Deuterostomia Name sometimes applied to a number of animal phyla (Chordata, Hemichordata, Pogonophora, Echinodermata, and Chaetognatha) thought by many to share a common ancestry. The name indicates the mode of formation of the mouth opening in embryogeny.

Devensian (Weichselian, Würm) The last glacial advance in N. Europe, approximately 100 000–18 000 years BP. It is approximately synchronous with the Wisconsin glaciation in N. America.

devilfish 1 *See* Plesiopidae. 2 *See* Octopoda.

devil ray *See* Mobulidae.

devil's coach horse (*Staphylinus olens*) *See* Staphylinidae.

devil's darning needles *See* Odonata.

Devonian The fourth of the six periods of the Palaeozoic Era and the first of the Upper Palaeozoic Sub-era. It began 410 million years ago and lasted approximately 65 million years. In Europe there are

both marine and continental facies present, the latter being commonly known as the Old Red Sandstone. Although originally described from the type area in Devon, the marine Devonian is subdivided stratigraphically into stages established in the exceptionally fossiliferous deposits of the Ardennes in Belgium. These stages are the Gedinnian, Siegennian, and Emsian of the Lower Devonian, the Eifelian and Givetian of the Middle Devonian, and the Frasnian and Famennian of the Upper Devonian. The subdivision of the marine deposits is based on lithologies and the presence of an abundant invertebrate fauna including goniatites and spiriferid brachiopods. The continental Old Red Sandstone deposits contain a fauna of jawless fish and plants belonging to the primitive psilophyte group. As a result of the Caledonian orogeny of late Silurian times, much of the British Isles was covered with continental red-bed facies.

dew Droplets of water that condense on to solid objects when the dew-point is reached. If the surface of such a solid object is cooled to below freezing point, hoar frost will form.

dewlap Fold of loose skin hanging below the throat.

dew-point The temperature, with constant pressure and water-vapour content, to which air must be cooled for saturation to occur. Dew-point may be determined from the dew-point hygrometer which indicates initial condensation on a cooled surface.

dew-point hygrometer *See* dew-point; and hygrometer.

dew pond Artificial, impervious hollow on a limestone substrate, e.g. chalk downland, used to store water for livestock. It is filled by rain, and the collection of dew is probably negligible.

dextran Branched-chain polysaccharide composed of D-glucose units: it acts as a storage compound in bacteria and yeasts.

dextrorse Growing or arising in a right-handed or clockwise spiral from the point of view of an observer. The term is applied to a climbing-plant stem, a chain of spores, etc.

dextrose *See* glucose.

DFD measure *See* density–frequency–dominance measure.

D-fructose *See* fructose.

D-glucose *See* glucose.

dhole (*Cuon alpinus*) *See* Canidae.

diachronism Lithological unit that differs in age from place to place.

diad *See* crystal symmetry.

Diadematacea (subclass Euechinoidea) Superorder of echinoids with perforate primary tubercles on the rigid or flexible test. The perignathic girdle is complete, and the dentition aulodont.

diadematoid In echinoids, applied to a compound ambulacral plate bearing three pairs of pores. The middle primary pore is the largest.

Diadematoida (superorder Diadematacea) Order of regular echinoids with ambulacra composed of simple or compound diadematoid plates. The gill slits conspicuously notch the peristomal margin. Diadematoids first appeared in the Upper Triassic.

diadromous fish Fish that regularly migrate between the sea and freshwater systems.

diagenesis All the changes that take place in a sediment at low temperature and pressure after deposition. With increasing temperature and pressure, diagenesis grades into metamorphism. Diagenic processes such as compaction, dissolution, cementation, replacement, and recrystallization are the means by which an unconsolidated, loose sediment is turned into a sedimentary rock, e.g. sand into a sandstone, or peat into coal.

diageotropic *See* diageotropism; and geotropism.

diageotropism Tropic response of a plant organ in which it takes up a position at right angles to the direction of the force of gravity.

diagnostic horizon Soil layer containing a combination of characteristics typical of that kind of soil.

diakinesis *See* meiosis.

dialect Among animals, differences in vocalizations (e.g. bird-song) occurring among local populations of the same species.

Dialium (family Leguminosae, subfamily Caesalpinioideae) Genus of tropical trees in which the leaves are pinnate. The flowers are reduced, with one, two, or no petals. The fruit is indehiscent, brittle-skinned, and drupe-like, with an edible mesocarp. The trees yield useful timber. There are about 40 species occurring in W. Malesia, Madagascar, Africa, and (one species) America.

diallelic Applied to a polyploid individual with more than two sets of chromosomes in which two different alleles exist at a particular gene locus.

dialysis Separation of dissolved crystalloids from colloidal macromolecules by means of a semipermeable membrane that allows the passage of the former but not of the latter.

diamond Crystalline form of carbon that is the hardest naturally occurring material (hardness 10 on Mohs's scale). It is of igneous origin and is frequently found associated with kimberlites.

diamond fish *See* Monodactylidae.

Dianthidium *See* mason bee.

Dianthus (family Caryophyllaceae) Genus of mostly perennial herbs in which the calyx is tubular and enclosed tightly at the base by an epicalyx of 1–3 pairs of scales. There are five, long-clawed petals. The fruit is a four-toothed capsule. Many species, e.g. pinks and carnations, are grown for their beautiful, often sweet-scented flowers. There are about 270 species, found in northern temperate regions.

diapause Temporary cessation which occurs in the development of an immature insect. Insects can enter the diapause state as eggs, larvae, or pupae. Diapause is frequently associated with seasonal environments, the immature insect entering it during the adverse period, and breaking from it when more favourable conditions return.

Diapensiaceae Family of plants, most of which are cushion-forming, evergreen undershrubs, but a few of which are herbs. The calyx and corolla are deeply five-lobed; there are five stamens alternating with the corolla lobes; and the ovary is three-celled and lobed, and ripens to a capsule. There are six genera, with about 10 species, found in arctic and northern alpine regions.

diaphototropism Tropic response of a plant organ in which it grows at right angles to the stimulus of light.

diaphragm In mammals, a transverse partition separating the thoracic and abdominal cavities. When at rest the diaphragm is arched up into the thorax and its flattening plays an important part in breathing. It is composed partly of muscle and partly of tendon, and is covered by a serous membrane.

diaphysis The main part of a bone. In a long bone it is the shaft; in a vertebra the centrum.

diapir Upward-directed dome-like intrusion of a lighter rock mass, e.g. salt or granite, into a denser cover. The process is termed diapirism.

diapirism *See* diapir.

Diaporthaceae (order Sphaeriales) Family of fungi in which the asci have a refractive apical ring and are often embedded in a slimy mass. There are many genera, saprotrophic or parasitic on plants. Some can cause plant diseases.

Diapsida Class of reptiles with skulls that have two temporal openings behind the eye. They are often divided into two subclasses: the more primitive Lepidosauria (the scaly reptiles), represented today by lizards, snakes, and the rhynchocephalian, lizard-like *Sphenodon* (tuatara); and the more advanced Archosauria, which includes crocodiles, dinosaurs and pterosaurs. The earliest known diapsids date from the end of the Palaeozoic. They occur in S. Africa in Upper Permian and Lower Triassic rocks. Birds are closely related to the archosaurs, and although their skulls have only one temporal opening, this is apparently derived from the fusion of the two diapsid apertures.

diapsid type In Reptilia, describes a skull in which the post-orbital and squamosal bones form a bar across each temple, producing two temporal openings, one above the other. Most Mesozoic reptiles had skulls of this type, as have their modern descendants the Crocodilia and Squamata; but the feature was also shared by less advanced forms. Formerly many authorities grouped all such reptiles in the subclass Diapsida, but the arrangement has been largely abandoned as the more primitive and more advanced forms are not clearly related to one another.

Diarthrognathus broomi Of the many mammal-like reptiles recorded from the Triassic, this species is one of the closest to mammalian ancestry. It is assigned to the Ictidosauria and is characterized by a number of advanced cranial features. The skull of *Diarthrognathus* is only 4–5 cm long and its dentition is not as specialized as that of certain other mammal-like reptiles from the Upper Triassic.

diaspore Spore, seed, or other structure that functions in dispersal; a propagule.

diastema Naturally-occurring gap in the tooth row, most commonly between the incisors and first premolar.

diastrophism Deformation of the Earth's crust on a large scale. Faulting, folding, and plate movement can be involved, to produce mountain ranges, rift valleys, continents, and ocean floor.

diatom Alga which belongs to the class Bacillariophyceae. It is a microscopic, one-celled plant growing in marine or fresh water. These phytoplankton have a wall of overlapping halves (valves) impregnated with silica. The bivalved shells, or frustules, of silica material are an important constituent of deep-sea deposits.

diatomaceous earth (kieselguhr) Deposit composed of fossil diatoms, which is mined for many industrial uses: as a mild abrasive in metal polishes, as a filtering medium (e.g. in sugar refineries), for insulation of boilers and blast furnaces, etc. Vast deposits of diatomaceous earth are mined at Lompoc, California, USA.

diatomite Diatom-rich sediment, which has been laid down mostly in a deep-sea environment. The diatom cell wall is made from silica and the sediment is therefore of a siliceous nature.

diatom ooze Soft, siliceous, deep-sea deposit composed of more than 30% (by volume) diatom shells. Diatomaceous sediments predominate in the high latitudes both around the coast of Antarctica and in the N. Pacific, but in the N. Atlantic the diatom content is overwhelmed by the terrigenous sediment derived from the adjacent continents.

diatreme Volcanic vent that has formed by explosive action: it is often filled with coarse, angular fragments injected by gas fluidization, e.g. kimberlites.

diatropism Tropic response of a plant organ in which it grows at right angles to a stimulus.

diazotroph Organism capable of utilizing ('fixing') atmospheric nitrogen.

Dicaeidae (flowerpeckers, pardalotes; order Passeriformes) Family of small, often brightly coloured, short-tailed birds, with bills varying from thin and curved to stout, some being serrated. The birds are arboreal and often gregarious, feeding on insects, nectar, and fruit, and nesting in trees (flowerpeckers) or in holes in trees or banks (pardalotes). There are seven genera, with 58 species, found from S. Asia to Australia.

Dicaeum (flowerpeckers; family Dicaeidae) Genus of typical flowerpeckers, with fine to stout serrated bills and a vestigial outer primary. They inhabit forests, feeding on insects, nectar, and berries. Many act as disseminators of seeds, e.g. *D. hirundinaceum* (mistletoe-bird) scatters mistletoe seeds. They build domed, pendant nests. There are 36 species, found from S. Asia to Australia.

Dicaeum hirundinaceum (mistletoe-bird) *See Dicaeum*.

dicaryon *See* dikaryon.

Dicentra *See* Fumariaceae.

dicentric Applied to a chromosome or chromatid with two centromeres.

Diceratiidae (class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of thickset, almost rotund, marine deep-sea fish with a large mouth, short fins, small eyes, and a very long dorsal-fin spine projecting over the mouth. There are about four species, occurring worldwide.

dice snake *See Natrix tessellata.*

Dichapetalaceae Family of shrubs, climbers, and small trees, which have simple, alternate, often pubescent leaves without stipules. The inflorescence is a cyme or cluster, with a stalk. The flowers are regular or irregular, bisexual or unisexual, and monoecious. There are five overlapping sepals and four or five bilobed or forked petals, which are often black. The five stamens are united to the petals, or free. The ovary is superior, with two or three biovular carpels, each with two styles. The fruit is a drupe, usually lobed and pubescent, with up to three locules, each with a single seed. The seeds contain no endosperm. There are four genera, with about 200 species, found throughout tropical regions. Some species are cultivated as ornamentals. Many are very poisonous, and are used locally to poison game or vermin.

2,4-dichlorophenoxyacetic acid (2,4-D) *See* auxin.

Dichobunidae Small, primitive, Eocene and early Oligocene artiodactyls which were formerly grouped into this one family. They show considerable variation, however, and more recently they have been regarded as a distinct artiodactyl group of subordinal status, the Palaeodonta. They were neither true swine nor true ruminants.

Dichoporita (class Rhombifera) Order of echinoderms, characterized by the possession of endothecal pores which are developed only across certain plate sutures, by a theca composed of a small number of plates in 3–5 circlets, and by a well-developed stem retained throughout life. They are known from the Lower Ordovician to Upper Devonian.

dichthadiiform *See* Dorylinae.

Dickinsoniida (class Dipleurozoa) The only order in its class, comprising Coelenterata showing 70–140 simple lateral segments, the segments being more numerous and less oblique at one end than at the other. They are known from the Lower Cambrian of S. Australia.

dicondylar With a double articulation.

dicotyledon (Dicotyledoneae) One of the two great divisions of the angiosperms (flowering plants) in which the embryo characteristically has two cotyledons (though sometimes there are more).

Dicranales (subclass Bryidae) Order of mosses, which may be large or small. The leaves are long, and narrow to ovoid; each has a single nerve. Genera include *Dicranella*, *Ceratodon*, *Dicranoweisia*, *Dicranum*, *Campylopus*, and *Leucobryum*. Species are numerous and widespread, found on a range of substrates.

Dicranum (order Dicranales) Genus of medium-sized to large mosses in which the shoots are erect and unbranched. The leaves are long and slender, and in many species are curved to one side (falcato-secund). *D. majus* is a large, striking moss of mountain woodland, with strongly falcato-secund leaves up to 1.5 cm long. *D. scoparium* is similar but smaller; it is very common on the ground in woodland clearings, on heathland, etc. The genus is cosmopolitan, with about 150 species.

Dicruridae (drongos; order Passeriformes) Family of small to medium, glossy black birds with stout, hooked bills and rictal bristles, some being crested. Their tails are medium to long, often having distinctive curled or racquet-shaped feathers. They are aggressive and inhabit forests, flycatching for insects and building open or semi-pendant nests. There are two genera, with 20 species. The monotypic genus *Chaetorhynchus* (*C. papuensis*, Papuan mountain drongo) has 12, not 10, tail feathers, and is endemic to New Guinea.

Dicrurus (drongos; family Dicruridae) Genus containing most of the drongos. *D. hottentottus* (spangled drongo) has at least 31 subspecies and is one of the most variable birds. There are 19 species, found in Africa, from S. Asia to Australia, and on many Pacific Ocean islands.

Dicrurus hottentottus (spangled drongo) *See Dicrurus.*

Dicteriastidae *See* Heliocharitidae.

Dictyoceratida (class Demospongiae, subclass Ceractinomorpha) Order of sponges which have no spicules. The skeleton is composed entirely of organic fibres, which may enclose detritus. A tough dermis is present. The fibre structure is quite complex. The order includes the commercial sponges used by humans.

Dictyocyathus During the Cambrian Period flask- or vase-shaped animals with a porous wall structure flourished in garden-like reefs. These were called archaeocyathids. *Dictyocyathus* is an early representative of this group from the Lower Cambrian of Siberia.

Dictyonema flabelliforme One of the best known of all graptolite species, is characteristically conical or bell-shaped in outline, with numerous branches connected by horizontal crossbars (dissepiments). *D. flabelliforme* is a dendroid graptolite which was probably planktonic in its mode of life. It ranged from the Cambrian into the Carboniferous.

Dictyoptera (class Insecta) Order of insects which includes the cockroaches and mantids. This classification is little-used, the order having been split into the two orders Blattodea (cockroaches) and Mantodea (mantids).

dictyosome The Golgi body in a plant cell.

Dictyosperma (family Palmae) Genus of palms, including *D. album* (the princess palm) which is very widely cultivated and of similar general appearance to *Archontophoenix alexandrae*. The trunk is solitary, and prominently hoop-marked; the leaves are pinnate with a conspicuous green

crown-shaft, below which appear the pendulous, simply branched inflorescences, at first enclosed in a large, broad, flat spathe. There are two species, native to Mauritius and the Rodrigues Islands, in the SW Indian Ocean.

dictyostele *See* solenostele.

Dictyosteliales (subclass Dictyostelidae) Order of slime moulds with the characteristics of the subclass, species of which are common and occur in a wide range of habitats including soil, dung, decaying plant material, etc. There are two families, with four genera.

Dictyostelidae (class Acrasiomycetes) Subclass of slime moulds in which the myxamoebae have slender pseudopodia. Prior to fruiting, the myxamoebae collect into streams, eventually aggregating to form a pseudoplasmodium. The subclass contains a single order.

Dictyostelium (order Dictyosteliales) Genus of cellular slime moulds, including *D. discoideum* which has been studied particularly as a model differentiation system. In this species the pseudoplasmodium is up to 4 mm in length, and the fruiting body consists of a mass of spores borne at the tip of an unbranched, tapering stalk. There are 20 species in the genus. They are found in soil, dung, decomposing vegetation, etc.

Dictyotales (class Phaeophyceae) Order of brown seaweeds in which growth occurs from a single apical cell or an apical margin of cells. The thallus is flattened and there is an isomorphic alternation of generations (i.e. the sporophyte and gametophyte generations are morphologically similar). Members are common in warmer regions. *Dictyota dichotoma* is yellowish-brown to olive-brown, and the flattened fronds fork regularly; this species is found in intertidal regions in rock pools, and in deeper water at and below low-water mark.

Dicyemida (phylum Mesozoa) Order of small mesozoans which have an elongated body. Their life cycle is complicated, mature individuals being endoparasites within the kidneys of cephalopods.

didactylous In Marsupialia, applied to the condition in which the second and third hind digits are not united within a common sheath.

Didelphidae *See* Didelphoidea.

Didelphoidea (infraclass Metatheria, order Marsupialia) Superfamily comprising the opossums (family Didelphidae) and extinct relatives known since the Upper Cretaceous. Possibly they are the least modified of all therian mammals. They are arboreal (except *Chironectes*, an otter-like, semi-aquatic form), mainly nocturnal, insectivorous or omnivorous marsupials, in which the marsupium may be well developed or (more usually) absent. There are more than three pairs of incisors in both upper and lower jaws. The second and third digits of the hind feet are didactylous. Didelphoids are distributed throughout tropical and subtropical America. There are twelve genera, and about 66 species.

Didinium (suborder Rhabdophorina) Genus of ciliate protozoa which possess a cytostome at the tip of the cell. The cell body is ovoid and radially symmetrical, with two bands of cilia encircling the body. *Didinium* feed exclusively on species of *Paramecium*, and are found in still freshwater environments, e.g. ponds and lakes. There are two species.

Didolodontidae (superorder Protoungulata, order Condylarthra) Extinct family of ungulates which lived from the Palaeocene to the Miocene in S. America, and which may have given rise to later ungulates characteristic of S. America.

differential species In phytosociology, species which seem to be mutually exclusive in a comparison of two community types, but which examination of other communities reveals are not necessarily characteristic for either community. *See also* kennarten species.

differentiation 1 (fractionation) Formation of a variety of rock types from an initial single parental rock. No specific mechanism is implied by the term. *See* fractional crystallization. 2 The occurrence of changes in the structure and function of groups of cells due to increased specialization in an organism.

differentiation, theory of On the basis of the different distribution patterns of the families, genera, and species of flowering plants, it was suggested by some early plant geographers that evolution in this group proceeded from the family level downward into genera and species, rather than the other way around.

diffusion Movement of molecules from a region of higher to one of lower solute concentration as a result of their random thermal movement.

diffusion pressure deficit *See* suction pressure.

Digenea (flukes; phylum Platyhelminthes) Class—or in some classifications an order of the class Trematoda—of parasitic, platyhelminth worms all of which have a gut and an anterior (oral) sucker. Most have an intestine, a pharynx, and a ventral sucker. Mature individuals lack cilia. The initial hosts are certain molluscs; the fluke then leaves and develops in a vertebrate host. All flukes are endoparasitic.

digger wásps *See* hunting wasp; Sphecidae; and Sphecoidea.

Digitalis (foxgloves; family Scrophulariaceae) Genus of tall herbs with alternate leaves and attractive, drooping, two-lipped, bell-like flowers. They are cultivated for their flowers and for the alkaloid digitalis, used for heart stimulation. There are about 20 species, found in Europe and Central Asia.

digitigrade Applied to a gait in which only the digits make contact with the ground, the hind part of the foot remaining raised.

dikaryon (dicaryon) Fungal hypha or mycelium in which each cell contains two nuclei which (usually) are genetically distinct.

dike *See* dyke.

dill (*Anethum graveolens*) *See Anethum*.

Dillenia (family Dilleniaceae) Genus of trees and shrubs. Their flowers, which are showy, have five sepals and petals; numerous stamens, developing centrifugally; and numerous carpels. The seeds are often arillate. Some species are cultivated as ornamentals, and some yield useful timber. There are 60 species, occurring from the Mascarenes and Indo-Malaysia to the Pacific islands.

Dilleniaceae Family of trees, shrubs, and herbs, in which the leaves are simple, without stipules. The flowers are showy and hermaphrodite, with free, imbricate sepals and petals; usually many stamens; and a superior ovary of one to many, usually free carpels. The fruit may or may not be dehiscent, and is subtended by the persistent calyx. The seeds are sometimes arillate. There are 10 genera, with 200 species occurring in the Old and New World tropics and subtropics, and well represented in Australia.

dimension analysis The detailed measurement of plant dimensions in productivity studies. Control studies enable estimation of statistical relationships between external dimensions and dry-matter production, so that in future studies destructive sampling (harvesting techniques) is unnecessary. Dimension analysis has particular relevance to forest-productivity studies. The classic work is the study by R. H. Whittacker on the Brookhaven Forest, New York (published in the *Journal of Ecology* in 1969).

dimer Protein made up of two polypeptide chains or subunits paired together. If the subunits are identical in amino-acid sequence the protein is said to be homomeric; if they are different, it is heteromeric. Dimeric proteins may be detected by electrophoresis. In monomeric enzymes, the isozyme pattern of the heterozygote will represent a simple mixture of the two forms occurring by themselves in each of the corresponding homozygotes. In dimeric enzymes, there are homomeric forms representing the two homozygotes, but the heterozygote occurs in heteromeric form: when stained after electrophoresis, this results in three bands (instead of two bands as with a monomer). An example of a dimeric enzyme is glucose-phosphate isomerase. Some enzymes are trimeric (comprising three components) or tetrameric (with four components).

Dimetrodon angelensis Large, specialized, meat-eating reptile from the Lower Permian of North America. *Dimetrodon* had a synapsid-type skull and is grouped amongst the pelycosaurs. It grew to over 3 m in length and is noted for the presence of a large sail on its back. The skull of this carnivore was high and narrow, with the teeth differentiated and well adapted to predatory habits.

dimictic Applied to a lake in which two seasonal periods of free circulation occur, as is typical of lakes in mid-latitude climates. In summer, thermal stratification occurs as surface waters are warmed and cease to mix with the denser, colder, deep waters. In winter, when they cool to below 4 °C, surface waters expand, so becoming less dense than warmer waters beneath them, giving a reverse stratification. Free circulation through the depth of the lake is possible only in spring, when the surface temperature rises to above 4 °C, and the water becomes heavier than that beneath and so sinks and mixes, and in autumn, when the surface (epilimnion) waters cool to the temperature of the deep (hypolimnion) waters.

dimidiate 1 Divided into two. 2 (Of a fungal fruit body) Semicircular in outline.

dimorphic fungi Fungi that can exist either as single, yeast-like cells or as filaments, depending on conditions.

dimorphism The presence of one or more morphological differences that divide a species into two groups. Many examples come from sexual differences of particular traits, such as body size (males are often larger than females), or plumage (male birds are usually more colourful than females). These result from sex-linkage of the genes coding for the particular trait. However, some dimorphisms, such as the aerial or submerged leaves of some aquatic plants, and the colour-phases of some birds, may not be sex-linked.

Dimorphodon macronyx Early, rather primitive representative of the pterosaur group of flying reptiles, *Dimorphodon* possessed a large head and a long, reptilian tail. The species is known from the Lower Jurassic of Europe.

dimyarian Applied to a condition in pelecypods, in which two adductor muscles are present, one anterior and one posterior.

dingo (*Canis dingo*) *See* Canidae.

Dinilysia Genus of snakes known from the Cretaceous. Snakes are poorly known in strata of Cretaceous age, but *Dinilysia*, a 2 m long booid, is recorded from the Late Cretaceous of Patagonia.

Dinocerata (Uintatheres; cohort Ferungulata, superorder Paenungulata) Extinct order of mainly N. American ungulates of the late Palaeocene to Eocene. Some were the size of a modern rhinoceros, ponderously built, with pairs of horn-like bony swellings on the upper side of the nasal, maxillary, and parietal bones of the skull.

Dinoderus minutus (bamboo borer) *See* Bostrichidae.

dinoflagellate Motile (flagellated) member of the class Dinophyceae.

Dinogamasus *See* acarinum.

Dinomyidae (pacarana; order Rodentia, suborder Hystricomorpha) Monospecific family (*Dinomys* species) of ground-dwelling rodents marked by white stripes along the back and spots on the flanks. They are confined to the western part of tropical S. America.

Dinophyceae Class of algae which are mainly unicellular. The cell typically has a transverse furrow (the girdle) and a longitudinal furrow (the sulcus); the girdle divides the cell into two halves called the epicone and hypocone. Some members are 'armoured', i.e. they have thick cellulose plates which lie in vesicles beneath the plasmalemma; others have empty vesicles or only thin plates.

Typically two flagella are present. Many species are capable of emitting light, and members of this class are main contributors to bioluminescence in the sea. Most are planktonic in marine and freshwater environments; some occur in symbiotic association with animals, e.g. the flatworm *Amphiscolops*, marine anemones, and corals, the symbiosis being based on the exchange of nutrients between symbionts. There are six orders, with many species.

Dinornithidae (moas; order Dinornithiformes) Extinct family of large emu-like ratites, the largest being 3 m tall. They had no wings, and were herbivorous and ground nesting. They became extinct during the last few hundred years, some possibly surviving into the nineteenth century. There were at least six genera, with 19 species, confined to New Zealand.

Dinosauria Literally the name means 'terrible lizards', but in fact the dinosaurs were not lizards. They were diapsid reptiles whose closest living relatives are the crocodilians and birds. Dinosaurs first appeared in the Middle Jurassic and produced an astonishing array of different types and sizes before becoming extinct at the end of the Cretaceous. The two groups of dinosaurs, Saurischia and Ornithischia, are not usually thought to be more closely related to each other than to other archosaurs, so the concept of 'dinosaur' is a heterogeneous one.

Diodontidae (porcupine fish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Small family of marine, warm- to temperate-water fish in which the short, rotund body is covered by numerous hard spines. The teeth are fused in each jaw, resembling the beak of a parrot. Porcupine fish are well known for their peculiar habit of distending themselves with water until the body assumes a nearly spherical shape. The inflated, dried skin has been used to make lampshades. There are at least 15 species, inhabiting the coastal regions of the oceans.

dioecious Possessing male and female flowers or other reproductive organs on separate, unisexual, individual plants; or male and female reproductive organs in separate, unisexual, individual animals. *See also* androecium.

dioestrus Period between two oestrous cycles in a female mammal.

Diomedea (albatrosses; family Diomedeidae) Genus of dark-brown or white albatrosses, most having dark upper wings. *D. exulans* (wandering albatross) has the largest wing-span of any bird, measuring 3.5 m. The largest albatrosses have fledging periods of 11 months and breed every two years. There are 11 species, found in southern oceans and the N. Pacific.

Diomedea exulans (wandering albatross) *See Diomedea*.

Diomedeidae (albatrosses; order Procellariiformes) Family of large seabirds with long narrow wings, a large head, and a long, strong bill with a hooked tip and tubular nostrils. They have short legs, webbed feet, and a reduced or absent hallux. They are pelagic, and often gregarious with a powerful, gliding flight. They feed on fish, squid, and other marine animals, coming to land only to nest. There are two genera, with 13 species, found in southern oceans and in the N. Pacific, occasionally wandering into other regions.

Diopsidae (stalk-eyed flies; class Insecta, order Diptera, suborder Cyclorrapha) Small family of flies whose eyes are borne on stalks. The head is usually sparsely haired, with vibrissae absent. The anterior femora are stout, with ventral spines. The larvae are saprophagic or phytophagous. Adult males have lost tergites seven and eight, and the seventh sternite forms a complete ventral band. There are some 150 described species, found mainly in Africa and Asia, but also in New Guinea and N. America.

diopside (hemimorphite) Mineral, specific gravity 3.3–3.4, hardness 5.5–6.0; chemical composition $CaMg(Si_2O_6)$. It is a common constituent of magmatic, basic, and ultrabasic rocks, e.g. pyroxenites, peridotites, gabbros, and diabases; it also occurs in basalts and dolerites. It is normally a pale, dirty green or grey (or, rarely, colourless), and it has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are usually short, prismatic, columnar grains, but the bulk are irregular grains. It is a rock-forming mineral.

dioptase Mineral, specific gravity 3.3, hardness 5.0, and chemical composition $CuSiO_2(OH)_2$. It occurs in the oxidized zone of copper-sulphide deposits. It is distinguished by its colour, crystal form, and association with copper minerals. It is emerald-green, transparent to translucent, and has a vitreous lustre. It crystallizes in the trigonal system. The crystals are usually short, prismatic, and terminated by rhombohedra, but it is also massive.

diorite Intermediate, coarse-grained igneous rock with up to 10% quartz. Plagioclase feldspars are of the oligioclase-andesine varieties; and ferromagnesian minerals, e.g. pyroxenes or hornblende, are present.

Dioscorea (family Dioscoreaceae) Genus of plants in which the twining annual stems arise from an often massive subterranean tuber: the tuber contains much starch, and is known as a yam. The leaves have palmate main nerves, and nervation as fine as a spider's web. Some species yield steroids used for oral contraceptives. There are 600 species, of the tropics and subtropics, one species occurring in Europe.

Dioscoreaceae Family of plants most of which are slender climbers. The leaves are commonly cordate. The flowers are regular, small, inconspicuous, tri- or hexamerous; the ovary is inferior. The fruit is a capsule or berry. There are six genera, with 630 species, most of which are tropical.

Diospyros (ebony; family Ebenaceae) Genus of small, gloomy trees which have monopodial crowns and charcoal-like outer bark. The heartwood is hard, dense, and dark brown streaked with black, and is a valuable timber. The plants are dioecious.

The fruit is a berry, seated on the persistent calyx. There are few seeds, which are bony. In several species the pericarp is edible. The persimmons are *D. kaki*, *D. lotus*, and *D. virginiana*. There are about 500 species, occurring in the warm parts of the world.

dip The angle formed between an inclined bedding plane and the horizontal plane. The dip angle of a given slope or bed is measured at right angles to the strike.

diphosphopyridine nucleotide (DPN) *See* nicotinamide adenine dinucleotide.

diphtheria Acute, infectious disease of humans, caused by toxin-producing strains of *Corynebacterium diphtheriae*. These strains contain a lysogenic bacteriophage, and it is the bacteriophage that is responsible for the production of the diphtheria toxin. Symptoms of diphtheria include malaise, sore throat, headache, and the development of a characteristic membrane in the throat which may impede breathing. The disease can be fatal.

diphycercal tail Possibly the original type of tail-fin in fish, in which the body axis divides the fin into equal dorsal and ventral sections.

Diphyllobothridea (phylum Platyhelminthes, class Cestoda) Order, or in some classifications family, of parasitic, platyhelminth worms which possess a simple scolex. Most inhabit three hosts during their development.

diphyodont Applied to vertebrates in which a set of deciduous teeth (milk teeth) is shed and replaced by a second set of (permanent) teeth.

diplanetism The phenomenon, observed in some members of the Oomycetes, of there being two distinct motile phases, with morphologically different zoospores formed in each.

Diplobathrida (subclass Camerata) Order of crinoids which have two circlets of plates beneath the radial plates (i.e. those which bear the arms). They range from Middle Ordovician to Lower Carboniferous in age.

diploblastic Applied to animals in which the body wall is composed of two layers of cells.

diplococcus The arrangement of cells in certain types of bacteria: cocci joined together in pairs.

Diploglottis (family Sapindaceae) Genus of trees of subtropical regions. It includes *D. cunninghamii* (native tamarind) of E. Australia, which grows to 17 m high, has pinnate, fern-like leaves, and small, yellow flowers borne in panicles. The yellow fruit contains a red pulp used for making jam. The genus comprises one or two species, endemic to Australia.

Diploglottis cunninghamii (native tamarind) *See Diploglottis*.

diploid Cell with two chromosome sets, or an individual with two chromosome sets in each cell (excluding the sex chromosomes which may or may not be represented twice, according to the sex of the individual). A diploid state is written as $2n$ to distinguish it from the haploid state of n. Almost all animal cells (except gametes) are diploid, as are the zygotes of many green algae and fungi, and the sporophytes of other algae, mosses, liverworts, and vascular plants.

diploidy The diploid condition.

Diplomonadida (class Zoomastigophorea) Order of protozoa which are bilaterally symmetrical and have 2–8 flagella. Most species are parasitic in vertebrates and some can cause disease.

Diplophylum (order Jungermanniales) Genus of leafy liverworts. *D. albicans* is a common and easily recognized species, with creeping primary stems from which arise numerous ascending or erect leafy shoots. The leaves are arranged in two ranks; each leaf is deeply divided into two lobes, the smaller of which is bent back and partly covers the larger, lower lobe, thus giving the appearance of two leaves rather than one. A whitish 'vein' consisting of a band of long, narrow, clear cells runs down the middle of each leaf. They are found on a range of non-calcareous substrates: soil, peat, rock, etc.

Diplopleurozoa (phylum Cnidaria) Extinct, primitive class, whose members had a bell-shaped body of elliptical outline, showing distinct bilateral symmetry. There was a median furrow along the main axis of the body, giving off numerous, flat, simple segments which reached the periphery and were separated by narrow grooves. The margins were scalloped into short lappets, each bearing a simple tentacle. They are known only from the Lower Cambrian.

Diploporita (subphylum Pelmatozoa) Class of echinoderms which have uniserial brachioles, theca composed of a large number of irregularly arranged plates, and exothecal structures present on all plates. They are known from the Lower Ordovician to Middle Devonian.

Diplostraca (clam shrimps, water fleas; phylum Arthropoda, subphylum Crustacea, class Branchiopoda) Order of branchiopod Crustacea in which the body is laterally compressed and at least partially enclosed in a bivalved carapace. The order comprises the two suborders: Conchostraca (clam shrimps) and Cladocera (water fleas). There are 605 species.

diplotene *See* prophase.

Diplozonina (starfish; subclass Asteroidea, order Paxilloda) Suborder of starfish in which the marginal frame consists of an upper and a lower pair of ossicles. The aboral skeleton consists of small, peg-like plates (paxillae) set in a flexible membrane. The tube-feet are pointed, and without terminal discs. The suborder first appeared in the Jurassic and persists to the present day.

Diplura Class and order of small (mostly 6 mm long or less), elongate, slender, whitish, blind, entognathous (i.e. with the mouthparts enclosed by the head capsule) hexapods. They have long, moniliform antennae, legs that are five-segmented, and abdomens that are ten-segmented and bear rudimentary limbs. There are two main families: the vegetarian Campodeidae, in which the abdomen bears long, moniliform cerci; and the carnivorous Japygidae, in which the cerci are short and

forceps-like. Post-embryonic development is epimorphic (with little change except for the addition of antennal segments and the development of the chaetotaxy towards the mature condition). The Diplura form a cosmopolitan order of some 659 species, found worldwide, whose members are the most insect-like of the entognathous classes and live in damp soil, under stones or logs.

Dipluridae *See* funnel web spiders.

Dipneusti (Dipnoi) Often ranked as a subclass, the group that includes the extant lungfish and their fossil relatives. The lungfish are an order of bony fish (Osteichthyes) in the subclass Choanichthyes (Sarcopterygii), or fleshy-finned fish. They first appear in early Devonian rocks and were common in freshwater habitats in the late Palaeozoic and Triassic. Thereafter their fossil remains are very sparse and now there are just three surviving types, all in the tropics. *See also* Ceratodiformes.

Dipnoi *See* Dipneusti.

Dipodidae (jerboas; order Rodentia, suborder Myomorpha) Family of nocturnal or crepuscular saltorial rodents in which the hind limbs are much elongated, the tail is long with a tuft at the tip, and in most species the eyes and ears are large. Apart from the specialization of their limbs, dipodids are rather primitive. They are distributed throughout arid and desert regions of the Old World. There are 10 genera, with about 27 species.

dipole A molecule with an uneven charge distribution, one pole having a net negative charge, the other a net positive charge.

dipole moment *See* polar molecule.

dippers *See* Cinclidae.

diprotodont In Marsupialia, applied to the condition in which the first incisor teeth are enlarged.

Dipsaceae Family of herbs or low shrubs, resembling the Compositae, but with opposite leaves. Each floret in the head has its own involucre of united bracts; the stamens are exerted, their anthers on long filaments. There are about nine genera, with 150 species, occurring mainly in S. Europe and W. Asia.

Diptera (two-winged flies, true flies; class Insecta) Order of insects in which the adults are characterized by the possession of a single pair of membranaceous wings, the hindwings having been modified into halteres. The mouthparts are generally suctorial, and modified into a proboscis, often adapted for piercing. Mandibles are normally absent. The prothorax and metathorax are small, and fused with the large mesothorax. The life history includes complete metamorphosis. Larvae lack true legs and are eruciform, with a maximum of 12 segments. Larval habits range from phytophagy to parasitism. The number of larval instars ranges from three (Cyclorrapha) to eight (Brachycera). The pupa is free, or enclosed in the last larval cuticle as a puparium; and is adecticous, abtect to exarate. The order is one of the largest within the class, with more than 85 000 described species. Most authors recognize three suborders: Nematocera (21 families), Brachycera (15 families), and Cyclorrapha (57 families).

Dipteridaceae Family of ferns with dichotomous, fan-like divisions of the fronds, and with superficial, non-indusiate, radiate, mixed sori. Most are tropical.

Dipterocarpaceae Family of resinous trees in which the leaves are simple, alternate, and stipulate. There are five twisted sepals and petals, and 5–10 stamens; the ovary is superior and trilocular. The fruit is a nut seated in the persistent calyx, with several sepals enlarged as wings. There are 15 genera, with about 600 species found in the Old World tropics. They are abundant in the lowland rain forests of W. Malesia, where there are many very lofty species.

Dipterocarpus (family Dipterocarpaceae) Genus of lofty, resinous trees which yield heavy, valuable timber (keruing and apitong). They have large amplexicaul stipules. The leaves are usually plicate between the main nerves. The wood of some is tapped for gurjun or keruing oil. There are 76 species, occurring from Sri Lanka to W. Malesia.

Dipteronia *See* Aceraceae.

direct circulation Circulation system in which lighter air rises, while denser air descends, leading to potential energy being converted to kinetic energy. Land- and sea-breezes are examples of such circulation.

directed speciation Speciational trend recognized in plants: the species do not conform to a continuum of adaptive types, but rather to a stepwise succession of distinct species. The evolutionary significance of such a trend is unclear. It may relate to differential survival as opposed to differential speciation along an environmental gradient, i.e. to species selection rather than directed speciation.

direct flight muscle Muscle which attaches directly to the wing of an insect. In most insects flight is powered by indirect flight muscles, while trimming of the wing movement for steering and other flight adjustments is brought about by the direct flight muscles. Dragonflies are unusual in using the direct flight muscles to power flight.

directional evolution *See* aristogenesis.

directional selection Selection that changes the frequency of an allele in a particular constant direction, either towards or away from fixation of that allele. It is often used in agriculture and horticulture to produce a shift in the population mean of a trait derived by humans. For example, the breeder might select for plants that fruit only in a season, or cows that yield more milk.

disafforestation *See* deforestation.

disassortative mating Mating between individuals of unlike phenotype. *See also* assortative mating.

Disasteroida (class Echinoidea) Order of irregular echinoids, characterized by an apical system in which all four genital plates, and three of the ocular

plates, are separated from the other two, posterior ocular plates by a series of catenal plates. The plastron (the posterior interambulacrum on the lower surface) consists of a series of alternating plates of equal size. The Disasteroida range in age from Lower Jurassic to Lower Cretaceous.

Dischidia (family Asclepiadaceae) Genus of epiphytes or bole climbers, many of which have concave leaves adnate to the bole, subtending adventitious roots, and containing commensal ants plus their accumulated frass. There are 80 species occurring in forests from Indo-Malaysia to Australia.

Discinacea (suborder Acrotetridina) Superfamily of inarticulate brachiopods, which show holoperipheral growth in the pedicle valve, which is usually conical to subconical. The phosphatic shell is homogeneous, finely punctate, and not in alternating organic and phosphate layers. All recent species are shallow-water forms, except one which is abyssal in habitat. The Discinacea appeared first in the Ordovician.

disclimax In the monoclimax model of vegetation development, a plant community replacing the climax community following an environmental disturbance, e.g. the introduction and maintenance of grazing pressure. 'Disclimax' is analogous to the more widely used terms 'plagioclimax' and/or 'biotic climax'.

discocarp *See* apothecium.

Discoglossidae (class Amphibia, order Anura (Salientia), suborder Opisthocoela) Family of toads which have disc-like tongues. The lower jaws are toothless; there are eight opisthocoelous vertebrae; the sternum is three-pronged; and the ribs are retained at metamorphosis. There are 15 species, in Europe and Asia, including *Alytes obstetricans* (midwife toad).

Discomedusae Alternative name for Semaestomatida.

Discomycetes (subdivision Ascomycotina) Class of fungi in which the fruiting body is generally a typical apothecium, i.e. cup-shaped or dish-shaped, with the hymenium exposed. They are saprotrophic, symbiotic, or parasitic. There are seven orders.

disconformity Unconformity such that the beds above and below the surface are parallel. Some disconformity surfaces are highly irregular, whereas others have no obvious relief.

discontinuity 1 Boundary or layer at depth, marked by a significant change in the speed of transmission of seismic waves, e.g. Mohorovičić discontinuity. 2 In meteorology, sharp changes in temperature, wind, or humidity across a frontal boundary.

discordance The cross-cutting relationship of one rock unit to others adjacent to it, e.g. a dyke (dike).

discordant intrusion *See* batholith; boss; and dyke.

Discosorida (class Cephalopoda, subclass Nautiloidea) Order of mainly curved, breviconic, shelled cephalopods in which the siphuncles are fairly large, and in some members of which camaral and siphuncular deposits occur. Some have reduced apertures. The siphuncle is almost central in position. The Discosorida range in age from Middle Ordovician to Upper Devonian.

discrimination (ethol.) Differential responsiveness to stimuli when several stimuli are presented simultaneously.

disc-winged bats *See* Thyropteridae.

Diselma (family Cupressaceae) Monotypic genus comprising *D. archeri*, a branched, gymnospermic shrub, which is usually about 2 m in height, but can be up to 6 m. The leaves are small, thick, blunt, and keeled. They are held closely to the stem and incurved against it, the stem appearing to be four-angled because of the positioning of the leaves. The male cones are solitary, terminal, and barely distinguishable from the vegetative branch tips. The female cones are solitary and terminal, with two pairs of scales and a central columella. The inner pair of scales has the ovules. The seeds have hardened and expanded wings. The genus is endemic to Tasmania, where it forms small stands in sub-alpine and wet conditions in the mountainous regions.

dishpan experiment Method for simulating the convective cell and other global atmospheric motions. A shallow layer of water in a round vessel is heated at the edge, to represent the equator, and cooled at the centre, to represent the polar region. As the dishpan is rotated various motions are produced in response to the radial temperature gradient and to the speed of rotation. With lower speed, the flow pattern is zonal, but with faster rotation large waves develop and incorporate closed circulations. *See also* Hadley cell; and Rossby wave.

disjunction Separation of homologous chromosomes at the anaphase stage of mitosis and meiosis, and movement towards the poles of the nuclear spindle.

Disparida (subclass Inadunata) Large order of monocyclic crinoids (i.e. there is only one circlet of plates beneath the radial plates which bear the arms) which developed bilateral symmetry. They range in age from Lower Ordovician to Upper Permian.

dispersal The tendency of an organism to move away, either from its birth site (natal dispersal) or breeding site (breeding dispersal): the opposite of philopatry. Rates of regional dispersal depend on the interaction of several factors, notably the size and shape of the source area, the dispersal ability of the organisms, and the influence of such other environmental factors as winds or ocean currents. Mathematical modelling using these factors has practical application in the design of nature reserves, and provides an insight into the present distribution of organisms. *Compare* philopatry.

dispersal barrier (ecological barrier) Area of unfavourable habitat separating two areas of favourable habitat, e.g. oceans in the case of terrestrial organisms, or a cereal monoculture in the case of woodland organisms.

dispersal biogeography Term now applied to the traditional school of biogeography, regarding organisms as arising in a centre of origin, and spreading out by stages, utilizing corridors, sweepstakes routes, etc.

dispersal mechanism Characteristic adaptation for dispersal which forms part of the reproductive strategy of many slow-moving or sessile organisms. It is most characteristic of the dispersal of spores, seeds, and fruit from plants, but is found in other organisms, especially for the dispersal of larvae. Typical examples are the hooked seeds and fruits that attach themselves to the coats of animals.

dispersion 1 In statistics, the internal pattern of a population, i.e. its distribution about the mean value. In spatial statistics, the pattern relative to some specific location, or of individuals relative to one another, e.g. clumped or random. 2 In pedology, the process of separating soil particles (as in aggregates) from each other so that they may react as individual particles. Aggregates or peds of soil particles are destroyed by dispersion (and formation is initiated by flocculation).

dispersion coefficient Measure of the spread of data about the mean value, or with reference to some other theoretically important threshold or spatial location, e.g. the standard deviation. *See also* dispersion; underdispersion; and overdispersion.

Dispholidus typus (boomslang; order Squamata, suborder Serpentes (Ophidia), family Colubridae) The only rear-fanged snake whose bite may be fatal to humans. An agile tree-snake (the common name means 'tree snake' in Afrikaans), it occurs in the African savannah, and is up to 1.8 m in length. Females are brown, males green. The diet consists of small vertebrates.

disphotic zone *See* aphotic zone.

displacement activity Behaviour of an animal that appears to be irrelevant to the situation in which it occurs and that may interrupt other activity. It may reduce conflict; or it may arise because the animal is prevented from attaining a goal, and the consequent frustration causes the attention to be switched to another stimulus to which it then responds.

display Stereotyped behaviour, largely acquired genetically, associated with courtship, in which physical characteristics (plumage, antlers, etc.) are exhibited by an animal as a means of attracting a sexual partner.

disruptive coloration Colour pattern in an animal, which is thought to disrupt the perceived contour of the body or parts of the body, thereby making the animal more difficult to see. Many freshwater and coastal marine fish exhibit varying colour patterns made up of stripes and patches of contrasting colours. It also occurs in other groups of animals (e.g. the stripes of a tiger).

disruptive selection Selection that changes the frequency of alleles in a divergent manner, leading to the fixation of alternative alleles in members of the population. The result after several generations of selection should be two divergent phenotypic extremes within the population. This may be achieved for example by selecting seeds from the longest and shortest ears of corn in a population over a number of generations.

dissepiment 1 In corals, small, horizontal, domed plates which form cyst-like enclosures around the edge of a corallite and which do not extend right across the corallite. 2 In graptolites, a strand of chitinous material which connects adjacent branches in a dendroid colony.

dissipation trail (distrail) Phenomenon of cloud evaporation caused by exhaust heat in the rear of an aircraft flight path. *See also* condensation trail.

dissolved load The part of a river's total load that is carried in solution. Five ions normally constitute approximately 90% of the dissolved load: chloride (Cl^-), sulphate (SO_4^{2-}), dissolved bicarbonate (HCO_3^-), sodium (Na^+), and calcium (Ca^{2+}). Generally the load is at its maximum concentration during low-discharge conditions when ground water is the main source of flow.

dissolved-oxygen level The concentration of oxygen held in solution in water. Usually it is measured in mg/l (sometimes in $\mu g/m^3$) or expressed as a percentage of the saturation value for a given water temperature. The dissolved-oxygen level is an important first indicator of water quality. In general, oxygen levels decline as pollution increases.

distemper Infectious disease which affects dogs, foxes, wolves, and other animals. Symptoms include fever, and discharge from the nose and eyes. The disease may develop to involve the gastro-intestinal and respiratory tracts, and fits due to involvement of the central nervous system may also occur. It is caused by a paramyxovirus.

Distichodontidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of African freshwater fish with a deep body; a rather produced, 'pointy' snout; a soft-rayed dorsal and an adipose fin; and forked tail-fin. Some species, e.g. *Distichodon rostratus*, have been kept as aquarium fish, but may reach 55 cm in C. African rivers. A few genera, e.g. *Citharinus*, are also placed in a separate family, the Citharinidae.

distichous In two ranks.

distrail *See* dissipation trail.

disturbance General term used to denote low-pressure features, e.g. a depression or trough. Disturbances commonly appear as waves in the major air flows in the mid-troposphere, e.g. the equatorial easterlies, the prevailing westerlies over middle latitudes, and the trade winds.

disulphide bridge Covalent bond formed between two sulphur atoms. It is a particular feature of peptides and proteins, where it is formed between the sulphydryl groups of two cysteine residues, helping to stabilize the tertiary structure of these compounds.

Ditomopyge During the Carboniferous and Permian, the number of trilobite genera fell consistently until the extinction of the group at the end of

the Palaeozoic. *Ditomopyge* was one of the last representatives of the family Phillipsiidae. It was comparatively small, with an opisthoparian suture, well-developed eyes and a fused pygidium or tail area. *D. scitula* is known from the Upper Carboniferous of N. America.

Ditrysia (order Lepidoptera) The suborder to which 95% of all lepidopterans belong. The female bears an egg pore on abdominal segment 9/10, and a separate copulatory opening on segment 8. This contrasts with the monotrysian condition, where a single opening serves for mating and egg laying. The venation of the forewing differs from that of the hindwing.

Diuris (family Orchidaceae) Genus of orchids found in habitats of low fertility. There are 38 species, all endemic to Australia and found mainly in the east or west, except for one that is found in Java.

diurnal Daily; as applied to such daily rhythms as the normal pattern of waking and sleeping, or the characteristic rise and fall of temperature associated with the hours of light and darkness. *See also* circadian rhythm.

diurnal-curve method Technique for measuring oxygen production in aquatic ecosystems as a means of assessing gross primary or community productivity. Dissolved oxygen measurements are taken throughout a 24-hour period so that oxygen production by day and use at night by the aquatic community can be assessed.

diurnal temperature variation Daily variations in temperature at a particular place, related to the local radiation budget. In mid-latitudes, for example, maximum temperatures usually occur after noon and minimum temperatures in the early morning. The range varies according to location, with high variation in continental areas, and low variation in maritime areas. The diurnal range in equatorial areas exceeds the annual variation in average temperature.

divergence 1 (evol.) Genetic segregation and differentiation within a taxon to the extent that distinct derivative taxa result. The divergence may be at the species, genus, family, order, or higher level. Thus it is possible to refer for instance to the divergence of reptiles and mammals from a stem group, to the divergence of mammal orders, and to the divergence of a breeding population into two related species. 2 (meteorol.) Situation in which, over a given lapse of time, more air flows out of a given area than flows in. Some subsiding motion can be expected to take place in the air over this region. Divergence can also result from differences of surface friction, e.g. by acceleration of offshore winds over the sea. *Compare* convergence.

diversification Increase in the diversity of distinct types in one or more taxonomic categories, i.e. species, genus, etc. Phanerozoic, well-skeletonized marine invertebrates provide an illustration: their diversity at phylum level remains much the same throughout, whereas at family level there is a peak at the mid-Palaeozoic, and a trough at the Permo-Triassic boundary; after this there is a steady increase to a second, higher peak in the Cenozoic.

diversity Most simply, the species richness of a community or area, though it provides a more useful measure of community characteristics when it is combined with an assessment of the relative abundance of species present. Diversity in ecosystems has been equated classically with stability and climax communities. Such generalizations may be criticized on many counts, however.

diversity index Mathematical expression of the species diversity of a given community or area, which includes due allowance for the relative abundance of different species present. Such indices (e.g. the Shannon–Wiener index) are generally considered an important means for comparison of community structure and stability. A different and specialized case of a diversity index is the 'biotic index' used in water-pollution studies.

diversivore *See* omnivore.

diving beetle *See* Dytiscidae.

diving petrels *See* Pelecanoididae.

divisive method System of hierarchical classification that proceeds by subdividing the whole into successively smaller and more homogeneous units.

dizygotic twins Fraternal twins produced by two separate ova fertilized simultaneously by separate sperms. Such twins are genetically no more alike than siblings. *Compare* monozygotic twins.

DNA *See* deoxyribose nucleic acid.

Dobson flies *See* Corydalidae.

docks *See* Polygonaceae.

Docodonta (class Mammalia, subclass Prototheria) Extinct order of primitive mammals, known only from teeth found in Upper Jurassic rocks. Their brains may have been larger than those of reptiles; probably their young were fed with milk; possibly they were homoiotherms; and perhaps they were insectivorous, arboreal, and nocturnal. They were about the size of, and must have resembled, shrews.

Doctor, the Local term for the W. African Harmattan wind: it refers to the health-giving properties of this wind.

doctorfish (surgeonfish) *See* Acanthuridae.

dodder *See Cuscuta*.

Dodonaea (hop bush; family Sapidindaceae) Genus of shrubs and small trees with simple or pinnate, alternate leaves, which are often sticky. The small, solitary flowers are in panicles, racemes, or clusters, usually white to red in colour, and often unisexual. The fruit is a large, membranaceous capsule, and three- or four-winged, similar to that of the hop, hence the common name. There are 60 species, found in tropical and subtropical regions, and especially well represented in Australia, where there are 55 species, 21 of those being in the arid zone.

dodos *See* Raphidae.

dog (*Canis familiaris*) *See* Canidae.

dogfish (*Mustelus mustelus*) *See* Carcharhinidae; and Squalidae.

dog lichen Common name for the lichen *Peltigera canina* in which the thallus is foliose with broad, spreading lobes, and margins that usually turn downwards. The upper surface is dark grey to greyish-brown when wet, and pale ash-grey when dry; it is downy, especially near the edges. The under-side is white or pale brown, with conspicuous, anastomising 'veins' and long white rhizines. It is common on the ground in woods, moors, and sand-dunes, and among mosses on rocks, walls, wood, etc.

dog louse (*Trichodectes canis*) *See* Trichodectidae.

dog stinkhorn *See Mutinus*.

dogwood *See Cornus*.

doldrums The oceanic equatorial zone, which has low pressure and light, variable winds. The zone moves seasonally north and south of the equator.

dolerite Intrusive, medium-grained, basic igneous rock, in which augite and labradorite (a calcium-rich plagioclase) are important components. Dolerites may occur as dykes, sills (e.g. Salisbury Crags in Edinburgh, Scotland), or plugs.

Dolichandrone (family Bignoniaceae) Genus of trees which have pinnate leaves and large, tubular flowers. The fruit is a pod with many small winged seeds. There are nine species, occurring in E. Africa, Madagascar, and from SE Asia to Australia.

Dolichoderinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of ants which have a single, flattened, petiolar scale, often overhung by the first gastral segment. Venom is extruded through a ventral, transverse slit at the tip of the gaster. There are about 500 species, with a worldwide distribution.

Dolichopodidae (long-headed flies; class Insecta, order Diptera, suborder Brachycera) Large family of flies which are generally small, bristly, and metallic green or blue-green. Their antennae have a dorsal or terminal arista, and they have a short, fleshy proboscis. The wing cells M and the first M_2 are confluent with cell Cu, and are very short. The tarsus has two pulvilli, and a straight or poorly lobiform empodium. Males have secondary sexual features that may affect almost any part of the body. As adults, the flies are thought to be predacious on tiny, soft-bodied insects, which are chewed before being sucked dry. The flies are also found on flowers, feeding on nectar and other plant juices. Most larvae are carnivorous within their particular habitat, which may be aquatic, or terrestrial in soil or leaf-mould. The larvae have 12 segments, and spiny pseudopods to aid locomotion. There are more than 2000 described species. *See also* venation.

Dolichopteryx longipes (spookfish) *See* Opisthoproctidae.

Dolicochoerus loudonensis Middle Oligocene peccary known from Europe. Living relatives include *Tayassu* from the New World.

doliform Barrel-shaped or jar-shaped.

doline (swallow-hole, sinkhole) Steep-sided, enclosed depression in a limestone region. It is normally located at a site of increased joint density which focuses drainage passing vertically through the rock. It enlarges by solution (carbonation) and by collapse, thus allowing a distinction between so-called solution and collapse dolines. A shaft may lead from its floor to a cave system.

doliolaria In Holothuroidea, a larval form in which the ciliated band forms rings around the body. It develops from the auricularian larva.

Dollo's law Evolutionary irreversibility: once regarded as inevitable, but now considered to apply mainly in special cases. The potential for further useful mutation may well be very limited in highly specialized organisms, since only those mutations that will allow the organism to continue in its narrow niche will normally be functionally possible. In such cases there is therefore a self-perpetuating, almost irreversible, evolutionary trend, so much so that it is regarded virtually as a law, 'Dollo's law' (after the palaeontologist Louis Dollo). The trend results from steady directional selective pressure, or orthoselection reinforced by specialization.

Dolomedes *See* Pisauridae.

dolomite Widely distributed rock-forming mineral, specific gravity 2.8–2.9, hardness 3.5–4.0, chemical composition $CaMg(CO_3)_2$ (pearlspar), which is usually secondary, having formed by the action of magnesium-bearing solutions on limestones. Magnesium-rich waters percolating through limestone often produce coarse-grained dolomite. An atom-for-atom exchange between calcium and magnesium takes place, with an overall reduction in volume and an increase in pore space. Dolomite may also form in evaporite-rich environments, when the limestones are replaced soon after deposition. It occurs too as a gangue mineral in hydrothermal veins particularly associated with galena and sphalerite. It is distinguished from calcite by the fact that it dissolves very slowly in cold, dilute acid; but it effervesces very readily when warmed. It is usually white or colourless, but can be yellowish and brown; and it has a white streak, and a vitreous lustre. It crystallizes in the trigonal system. The crystals are usually rhombohedral with curved, composite faces, and it is also massive and granular. It is used as a building stone and in the manufacture of bricks for furnaces.

dolphin (*Delphinus*) *See* Delphinidae.

dolphinfish *See* Coryphaenidae.

dome Anticlinal structure which plunges in all directions.

domestication Selective breeding by humans of plant and animal species in order to accommodate human needs. Domestication also requires considerable modification of natural ecosystems to ensure the survival of, and optimum production from, the domesticated species.

dominance 1 Possession of high social status within an animal group that exhibits social organization, often achieved and sustained by aggression toward inferior individuals. 2 *See* dominant gene.

dominant In ecology, the species having the most influence on community composition and form. Sometimes the term is also used to refer to the largest and/or most abundant species in the community.

dominant gene In diploid organisms, a gene that produces the same phenotypic character when its alleles are present in a single dose (heterozygous) per nucleus as it does in double dose (homozygous). For example, if *A* is dominant over *a*, then *AA* (the homozygote) and *Aa* (the heterozygote) have the same phenotype. A gene that is masked in the presence of its dominant allele in the heterozygote state is said to be recessive to that dominant. Such a dominance-recessive relationship is common between two alleles, the gene most frequently present at a given locus being usually dominant to its alleles.

Domin scale System for describing the cover of a species in a vegetation community. The scale ranges from simple presence through 10 grades of linked cover-abundance and cover measures. The scheme is based on the original five-point cover scale of Braun-Blanquet, but the finer subdivisions allow more detailed interpretation. *See also* cover-sociability scale.

Donatia (family Stylidiaceae, subfamily Donatioideae) Genus of small, sub-alpine cushion-plants found in wet areas. The leaves are densely arranged, alternate, and linear. The flowers are terminal, solitary, and sessile. The only genus in the subfamily, it comprises two species, found in Tasmania, New Zealand, S. America, and the sub-antarctic.

Donatiaceae *See* Stylidiaceae.

Donax (family Marantaceae) Small genus of herbs which have spreading rhizomes, and reed-like stems. There are three species, occurring in the lowland tropics from Indo-Malaysia to the Pacific.

donor *See* graft.

Doradidae (thorny catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of small catfish, recognizable by rows of thick, overlapping plates along each side of the body, each plate provided with a thorny process. The dorsal and pectoral fins each bear a strong spine. Doradidae usually have three pairs of barbels around the mouth. Several species are known to aquarium hobbyists, including *Amblydoras hancocki* (grunting thorny catfish), which can make audible grunting noises. There are about 130 species, found in S. American rivers.

dorado *See* Coryphaenidae.

dor beetle *See* Geotrupidae.

Dorcus parallelipipedus (lesser stag beetle) *See* Lucanidae.

dories *See* protrusible mouth; and Zeidae.

dormancy Resting condition with reduced metabolic rate. This is found in non-germinating seeds and non-growing buds.

dormice 1 *See* Gliridae. 2 (Chinese pygmy dormouse) *See Typhlomys*. 3 (spiny dormouse, *Platacanthomys*) *See* Platacanthomyidae.

Dorosoma cepedianum (gizzard shad) *See* Clupeidae.

dorsal 1 In a plant, abaxial (i.e. facing away from the stem). 2 In an animal, nearest to the back; in vertebrates to the spinal column.

dorsal aorta The main artery conveying blood to the posterior part of the body.

dorsal fin Unpaired fin located on the back (dorsal surface) of both bony fish and sharks. It may be single and soft-rayed, as in trout, or double with the anterior dorsal fin supported by fin spines, as in perch. In some species (e.g. eels) the dorsal fin is confluent with the tail-fin.

dorsiventral With upper and lower sides differing in structure.

Dorstenia (family Moraceae) Genus of herbs in which the flowers are borne on, or sunken in, a disc-like, flat, or concave receptacle, often over 2 cm across, and are unisexual and minute. When ripe, the fruit is ejected by the receptacle becoming turgid. There are 170 species, occurring in the tropics.

Doryanthus (family Amaryllidaceae) Genus of large herbs that grow in big clumps. They have sword-shaped, radical leaves up to 2 m long, a thickened underground stem, and contractile roots. The flowers are in a large head or panicle on top of a thick stem up to 3.5 m long, and are lily-like and usually red, surrounded by brown bracts. The fruit is a three-celled, woody capsule. The flat seeds germinate early and mature slowly, flowering only after several years. There are three species, endemic to the coastal areas of E. Australia.

Dorylinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of tropical ants which have one or two petiolar segments, and in which the eyes are reduced or absent. Colonies contain several million individuals, produced by the single dichthadiiform (permanently wingless, with a greatly enlarged gaster) queen. They are characterized by their legionary foraging activity (workers forage in groups), and nomadic behaviour (there are frequent changes in nest site). The bivouac (nest) is formed from the bodies of living ants, protecting the queen and brood within. There are about 200 species.

Doryphora (family Monimiaceae) Monotypic genus, *D. sassafras* (Australian or New South Wales sassafras), which is a tall tree, up to 30 m, with elliptical leaves up to 7 cm long, and toothed. The tree produces white flowers in winter. Both the bark and leaves are fragrant, and provide aromatic oils used in perfume. The tree is endemic to Australia and occurs as a dominant in the rain forests of Queensland and New South Wales or as an understorey to eucalypts in drier habitats.

dosage compensation Genetic process that compensates for genes that exist in two doses in the homogametic sex and one in the heterogametic sex as a result of their location on the X-chromosome.

dotard Decayed tree that is unsuitable for use as timber.

dottyback *See* Pseudochromidae; and Pseudogrammidae.

double coconut (*Lodoicea maldivica*) *See Lodoicea*; and Palmae.

double fertilization In flowering plants, the union of one sperm nucleus with the egg nucleus to form the diploid zygote, and of the other sperm nucleus with the two polar nuclei to form a triploid endosperm nucleus. The male gametophyte (pollen grain plus pollen tube) actually contains three sperm nuclei, but one (the vegetative nucleus) degenerates once double fertilization has been accomplished.

double refraction *See* birefringence.

douc langur (*Pygathrix nemaeus*) *See* Cercopithecidae.

Douglas fir *See Pseudotsuga*.

doum palm (gingerbread palm, *Hyphaene thebaica*) *See Hyphaene*.

dourine (mal du coit) Sexually-transmitted disease of horses and related animals, caused by the protozoon *Trypanosoma equiperdum*. Wild mammals appear not to be susceptible.

dovekie (*Alle alle*) *See Alle*.

doves 1 *See* Columbidae; and Columbiformes. 2 (fruit doves) *See Ptilinopus*. 3 (ground dove) *See Columbina*. 4 (quail dove) *See Geotrygon*. 5 (turtle doves, collared dove) *See Streptopelia*.

down Name applied to grassland in the lowland zone of Britain, which has been created and maintained by grazing. Typically such grassland occurs on chalk and limestone hills, but occasionally it is found on acidic rocks, such as the Old Red Sandstone of the Gower Peninsula in S. Wales.

downwelling (sinking) Sinking of ocean surface waters in some coastal areas as surface waters flow towards the coast. An example is along the Washington–Oregon coast (USA) in winter.

downy mildew Either a fungus of the family Peronosporaceae or a plant disease caused by such a fungus. The leaves of infected plants typically show yellowish spots or patches, with whitish or purplish mould on the under-side. A wide range of plants may be affected, each probably susceptible to a given species of fungus.

DPN (diphosphopyridine nucleotide) *See* nicotinamide adenine dinucleotide.

draa High (more than 300 m) sand ridge or chain of the Sahara, lying about 0.5–5 km from its nearest neighbour and moving at 2–5 cm per year. It is the largest land-form of the erg, or sand desert. A star-shaped dune, or 'rhourd', is developed at the site where two draa chains cross.

Dracaena (family Agavaceae) Genus mostly of trees whose stems branch and thicken by an extra-fascicular cambium. *D. draco* is the dragon tree. Trunks of several species exude dragon's-blood resin. There are 150 species, occurring in the Old World tropics and subtropics.

Dracontomelon (family Anacardiaceae) Genus of trees in which the leaves are pinnate, and the flowers pentamerous. The fruit is a drupe with edible, fleshy pulp, and a flattened, angular stone with one or two seeds. Several yield attractively coloured, valuable timber. There are eight species occurring in rain forest from Indo-Malaysia to Fiji.

Dracophyllum (family Epacridaceae) Genus of ornamental, winter-flowering shrubs with stem-clasping, sharply pointed leaves. The tubular flowers are white to red in crowded, one-sided, terminal racemes. The fruit is a small capsule and the seed is slow to germinate. The species of exposed habitats are small; some are cushion plants. There are 30 species, found in Australasia and New Caledonia.

Draco volans (flying dragon, flying lizard; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Species of small (about 20 cm long), insectivorous, arboreal agamids which have long tails, and five or six posterior ribs enlarged to support a gliding membrane. They parachute from tree to tree.

dragonet *See* Callionymidae.

dragonfish 1 (*Bathydraco scotiae*) *See* Bathydraconidae; and bathypelagic fish. 2 *See* Idiacanthidae. 3 *See* Melanostomiatidae. 4 *See* Pegasidae. 5 *See* Stomiatidae.

dragonflies *See* Aeshnidae; *Anax imperator*; Anisoptera; Anisozygoptera; Cordulegasteridae; Corduliidae; Epiophlebiidae; Gomphidae; Libellulidae; *Meganeura gracillipes*; Meganisoptera; Odonata; Petaluridae; *Sympetrum striolatum*; and Synthemidae.

dragon's blood *See Daemonorops*; and *Dracaena*.

dragon tree (*Dracaena draco*) *See Dracaena*.

drainage 1 The passage of water over and through the land surface, ultimately towards the sea. The arrangement of surface-drainage lines or stream channels is called the drainage pattern. Normally this varies from one area to another, due to differences in the underlying rock type and structure, or to the influence of earlier events in the history of the landscape. A dendritic pattern (like the veins of a leaf) may develop on homogeneous rock. The drainage network is the same pattern viewed geometrically. Drainage density is a measure of the average spacing between the streams draining an area. It is arrived at by dividing the total length of streams in an area by that area. Its magnitude is affected by factors such as the amount of rainfall, permeability of the ground surface, and age. Inconsequent (or insequent) drainage bears no apparent relationship to the underlying rock type or structure. Occasionally a drainage pattern may be superimposed, that is, it was established on an earlier surface (perhaps conformable with the immediately underlying strata, and standing well above the present landscape): subsequently the pattern was let down by incision across geological structures to which it bears no relation. An original pattern may be deranged or disturbed by the intervention of external factors including tectonic

activity and glaciation. 2 Process of removing the gravitational water from soil, using artificial or natural conditions, such that freely moving water can drain, under gravity, through or off soil. *See* mole drain; and tile drain.

drainage density *See* drainage.

drainage network *See* drainage.

drainage pattern *See* drainage.

drainage wind *See* katabatic wind.

dreikanter *See* ventifact.

Drepanididae (Hawaiian honeycreepers; order Passeriformes) Diverse family of orange, yellow, green, brown, grey, or black birds, with bills varying from long, thin, and decurved to stout and hooked. They are arboreal, feeding on nectar, fruit, and seeds, and nesting in trees and other vegetation. There are 8–11 genera, with 16 species, confined to Hawaii. Many species are endangered, and a further seven species are extinct.

drey The nest of a squirrel.

dried-fruit beetle *See* Nitidulidae.

drift 1 (geomorph.) Any sediment laid down by, or in association with, the activity of glacial ice. The term is often widened to include related submarine and lacustrine deposits. It was introduced by C. Lyell (1797–1875), who suggested that glacial deposits were laid down by melting icebergs which drifted across an ice-age sea covering Britain. 2 (genetics) *See* genetic drift.

driftfish *See* Nomeidae.

Drimys (family Winteraceae) Genus of small trees with spicy bark in which the flowers have a distinct calyx and corolla. It is the widest-ranging genus of the family. There are 70 species, occurring from Borneo to New Caledonia, plus an additional four in S. America.

dripstone (flowstone, speleothem) Calcium carbonate rock deposited in caves by the precipitation of calcite from water as excess dissolved carbon dioxide is diffused into the atmosphere. Dripstone takes various forms, including stalactites, helictites (having spiral form), curtains, ribbons, and stalagmites.

drive Outdated term used formerly to describe a type of motivation in animals, the psychological 'force' that leads to physical action. The term was abandoned because 'force' in the sense of 'physical energy' plays no direct part in psychological processes, and because the attempt to attribute a drive to each aspect of behaviour led to an uncontrollable proliferation of drives.

driver ant *See* Dorylinae.

drizzle Precipitation of very small (200–500 μm) water droplets generated by coalescence at the base of cloud such as stratus. *See also* crachin.

Dromadidae (crab plover; order Charadriiformes) Monotypic family, comprising *Dromas ardeola*. This is a white, plover-like bird with a black back, and black remiges and wing coverts. It has a medium-length, stout, black bill, and its legs are long with partially webbed toes, and a pectinate middle claw. It is found on coastal shores, feeding on crabs, crustacea, and molluscs, and nesting in a burrow. It is found along Indian Ocean coasts from the Red Sea to Burma, and on Madagascar and other islands.

dromaeosaurid Member of a coelurosaurid branch of the theropod dinosaurs, which developed from the genus *Dromaeosaurus* (the 'emu reptile'), known from the early Upper Cretaceous of Canada. Dromaeosaurids had relatively large brain cases and may have been among the most intelligent reptiles ever to have lived.

Dromaiidae (emu; order Casuariiformes) Monotypic family of birds, closely related to the Casuariidae. *See also* ratite.

Dromaius (emu; family Dromaiidae) Monotypic genus, *D. novae-hollandiae* (emu) is a large ratite with grey-brown, hair-like plumage, a stout bill, vestigial wings, and no tail feathers. It has long legs with three toes and short claws. It inhabits dry open country, feeding on vegetable matter and fruit, and nesting in a hollow in the ground. It is confined to Australia; a second species *D. diemenianus* (dwarf emu) is extinct and sometimes regarded as a subspecies.

Dromaius diemenianus (dwarf emu) *See Dromaius*.

Dromaius novae hollandiae (emu) *See Dromaius*.

Dromas ardeola (crab plover) *See* Dromadidae.

dromedary (*Camelus dromedarius*) *See* Camelidae.

drone The male of ants, bees, and wasps, whose only function is to mate with fertile females: the drone contributes nothing to the maintenance of the colony.

drone flies *See* Syrphidae.

drongos *See* Dicruridae; and *Dicrurus*.

Drosera (family Droseraceae) Genus of insectivorous herbs, often with creeping or tuberous rhizomes. They have rosette leaves, the leaf blade being circular or elongated, with stalked glands on the upper surface which secrete a sticky fluid on which insects become trapped. The plants are able to live in very poor soils, but most of the extra nutrient obtained from the insects is devoted to seed production and is not essential to the survival of the plant. *Drosera* are usually found in acid bogs. Several species are cultivated for interest and ornament. There are about 70 species, with cosmopolitan distribution, but they are especially well represented in Australia and New Zealand.

Droseraceae (sundews) Family of insectivorous herbs, in most of which the leaves are borne in rosettes bearing glandular hairs which secrete protein-digesting enzymes so that the soft parts of insects trapped on the sticky leaves are digested and absorbed. The plants occur mostly in boggy places or on poor, acid, stony soils, and they may benefit from extra mineral nutrients obtained from the insect bodies. The flowers are regular, in one-sided cymes. There are four genera, with about 100 species, with a cosmopolitan distribution.

Drosophila Genus of fruit-flies which contains about 2000 described species. Experiments on *D. melanogaster* and other species of this genus, by T. H. Morgan, Th. Dobzhansky, and others, have formed much of the basis of modern genetics, and continue to do so. The island of Hawaii is a site of active speciation amongst *Drosophila*.

Drosophilidae (fruit-flies; class Insecta, order Diptera, suborder Cyclorrapha) Large family of flies which are of great economic importance as pests of fruit and other plant tissue. The adults are usually small, with light-red eyes. The antennae are cleft in the second segment, and the arista is dorsally pectinate. The vibrissae are present, and postverticals are convergent. The costa of the wing is broken at the end of R_1, Sc is present but small, Cu_2 and 1A are present. Eggs are laid on or near the fermenting fruit, and the larvae feed in a semiliquid soup of ripe fruit. Adults have been accidentally introduced into new fruit-growing areas of the USA and recently have become a major pest of orchards. Species of the genus *Drosophila*, of which more than 2000 are recognized, include some of the animals about whose genetics most is known. Scientists now have complete gene maps of the chromosomes of at least one species, *D. melanogaster*. *See also* venation.

drought cycle Temporary and repetitive phase of drier conditions in an otherwise favourable environment, e.g. the 22-year drought cycles of N. American grasslands.

drum *See* Sciaenidae.

drumlin Smooth, streamlined, oval-shaped landform, in which one end is blunt and the other tapers. Drumlins may occur singly, but more commonly they are found within a large group or 'drumlin field'. Usually they are composed of boulder clay, but occasionally they are made of solid rock (hence 'rock drumlin'). They are believed to be formed beneath the outer zone of an expanding ice sheet, during a major advance: they result from the deposition of material carried by the ice, the axis of the drumlin lying parallel to the direction of the advance.

drumlin field *See* drumlin.

drupe Fleshy fruit, such as a plum, containing one or a few seeds, each enclosed in a stony layer that is part of the fruit wall.

drupelet Individual small drupes of some fruits, e.g. blackberry.

dry adiabatic lapse rate The rate at which dry (i.e. unsaturated) air cools when rising adiabatically through the atmosphere as a result of the utilization of energy in expansion. It is 9.8 °C/km. *See also* instability; saturated adiabatic lapse rate; and stability.

dryad's saddle Common name for the fruit-body of *Polyporus squamosus*. This species forms handsome, semicircular, kidney-shaped or fan-shaped fruit bodies up to 60 cm across. The upper surface is yellowish-brown with dark brown, flattened, feathery scales arranged in more or less concentric rings. The lower surface is whitish with angular pores. The stipe is lateral, sometimes very short. It is common on dead wood, but can also parasitize living trees.

dry air 1 (climatol.) Air with low relative humidity. 2 (meteorol.) Unsaturated air.

Dryandra (family Proteaceae) Genus of small trees and shrubs with narrow, toothed leaves. The flowers are yellow to red with a conspicuous pistil, borne in dense heads with a basal involucre of bracts. The woody seed capsules are held vertically at the base, and the seed is sometimes retained on the plant following the winter flowering. The genus is similar to *Banksia*. There are about 50 species, endemic to SW Australia.

Dryas Part of the characteristic three-fold late-glacial sequence of climatic change and associated deposits following the last (Devensian) ice advance and prior to the onset of the markedly warmer conditions of the current (Flandrian) interglacial. The type sequence was first described for Allerød in Denmark, and shows upper- and lower-clay deposits rich in remains of *Dryas octopetala* (mountain avens), and between them deposits of lake mud with remains of cool-temperate flora, e.g. tree birches. The colder *Dryas* phases mark times of cold, tundra-like conditions throughout what is now temperate Europe. The three-fold *Dryas*–Allerød–*Dryas* sequence forms Pollen Zones I, II, and III of the widely accepted late and post-glacial chronology of Europe. The basal, older, *Dryas* deposit forms Zone I; the Allerød Zone II; and the younger *Dryas* Zone III.

dry-bulb thermometer Thermometer that registers normal air temperature. It may be used in conjunction with a wet-bulb thermometer: the relative humidity can be found by measuring the depression of temperature registered by the wet bulb. *See also* hygrometer; and psychrometer.

dry ice Solid carbon dioxide. It is used in cloud seeding to cool air in supercooled clouds by sublimation at low temperatures. This can generate many ice crystals for further ice nucleation.

Dryinidae (suborder Apocrita, superfamily Bethyloidea) Family of small (1.5–10 mm long), black wasps which have a reduced wing venation but a distinct costal cell on the forewings and a jugal lobe on the hindwings. The antennae are not distinctly elbowed, are 10-segmented, and arise low on the face. The fore tarsi of the female are often chelate (pincer-like) and are used to grasp the host adult or nymph. The host is stung and becomes insensible, whereupon the female wasp lays her egg or eggs. The larvae are mostly ectoparasitic on the abdomens of adult or nymphal Fulgoroidea and Cicadelloidea (plant hoppers, leaf hoppers, and tree hoppers). The position of the parasite on the host varies; more than one may be present; and many species exhibit polyembryony, with up to 60 individuals resulting from a single fertilized egg. The family is relatively uncommon.

dry-matter production The expression of plant or animal productivity in terms of the dry weight of material produced per unit area during a specified

time period. It is a more easily achieved, though technically less accurate, measure of organic production than are calorific values; in the latter, the inorganic (ash) component can be separated. *See also* calorific value.

Dryobalanops (family Dipterocarpaceae) Genus of lofty, resinous trees which yield the valuable timber kagur. *D. aromatica* also produces Borneo camphor, crystalline in the wood. There are nine species, occurring in Sumatra, Malaya, and Borneo.

Dryopidae (class Insecta, order Coleoptera) Family of tiny, pubescent, black to reddish beetles, less than 5 mm long. The antennae are very short and thick, with six or more segments forming a pectinate club. They live in or near water, crawling on aquatic vegetation. Larvae often have tufts of external gills at the end of the abdomen, or a mobile operculum, and are found under stones in streams or in permanently waterlogged fields. There are 250 species.

Dryopteris (buckler ferns; family Aspleniaceae) Genus of ferns in which the rhizome is short, stout, and scaly, with leaves in a crown, much pinnately divided. The sori are superficial, rounded, and with kidney-shaped indusia. There are about 150 species, found mainly in northern temperate regions but also widespread in the tropics.

Dryptodon *See* copper mosses.

dry rot 1 Any of several plant diseases which are characterized by the formation of dry, shrivelled lesions; they are due usually to fungal infection. 2 Serious type of timber decay in buildings, caused by the fungus *Serpula lacrymans*. Typically, infected timber is cracked, and bears a surface growth of white mycelium; leathery fruit bodies bearing rust-coloured spores may appear.

dry season Period each year during which there is little precipitation. In tropical climates, e.g. over much of India, the dry period is often in the winter season. In places in very low latitudes, two dry seasons may occur each year, between the northward and southward passage of the equatorial rains. In subtropical, Mediterranean, and west-coast climates, the dry season is in the summer.

dry valley Linear depression that lacks a permanent stream but that shows signs of water erosion. It is a common land-form in areas underlain by permeable rock, e.g. the Chalk of S. England. It is fashioned during an episode of surface drainage (perhaps during permafrost conditions), during a period of higher precipitation, or as a result of a fall in the water table.

DSL *See* deep scattering layer.

Duabanga (family Sonneratiaceae) Genus of large trees which have a monopodial crown, and drooping branches with terminal clusters of white, nocturnal, bat-pollinated flowers. The fruit is a capsule. *Duabanga* produce pale, light, useful timber. There are two species, occurring from the Himalayas to New Guinea.

Dublin Bay prawn *See Nephrops norvegicus*.

Duboisia (corkwood; family Solanaceae) Genus of tall shrubs, up to 6 m. They have obovate leaves (stalk at the narrow end, the leaf widening towards the tip), and white, star-like flowers; and they yield the alkaloid duboisine. *D. myoparoides* and *D. hopwoodii* were used by the aborigines as pituri, a chewed narcotic. There are three species, mainly restricted to Australia.

duck-billed platypus (*Ornithorhynchus anatinus*) *See* Ornithorhynchidae.

duckbill eel *See* Nettastomidae.

ducks 1 *See Anas*; and Anatidae. 2 (eiders) *See Somateria*. 3 (mergansers, sawbills) *See Mergus*. 4 (pochard) *See Aythya*. 5 (scoters) *See Melanitta*. 6 (stiftails) *See Oxyura*. 7 (whistling ducks) *See Dendrocygna*.

duck virus hepatitis Disease, chiefly affecting ducklings, which involves haemorrhagic necrosis of the liver. Mortality rates are high. The disease is caused by an enterovirus.

duckweed *See* Lemnaceae.

ductless gland *See* endocrine gland.

ductus pneumaticus *See* phytostomous.

Ducula (imperial pigeons; family Columbidae) Genus of medium to large pigeons; mainly grey and pink with green iridescent feathers, others pied. They are arboreal, feeding on fruit and leaves, and nesting in trees. There are 36 species, found in S. Asia, the Philippines, Indonesia, Australasia, and some Pacific Ocean islands.

duffers *See* Nymphalidae.

Dufourea *See* Halictidae.

Dufour's gland Abdominal gland found in the females of nearly all apocritan Hymenoptera. It empties at the base of the ovipositor or sting, and is thought in many groups to lubricate the valves of the ovipositor during egg-laying. In worker ants it secretes either alarm or trail-making pheromones. It is massively developed in most solitary mining bees, and produces secretions to make a waterproof, fungus-resistant lining for brood cells. In at least two bee families (Anthophoridae and Megachilidae) the Dufour's gland secretion is also a dietary supplement for the developing larva, and is added to the pollen and nectar stored by the female before egg-laying.

Dugongidae (dugong; superorder Paenungulata, order Sirenia) Family of large (up to 5.8 m long), exclusively marine 'sea cows' which have notched tails, and moderately cleft upper lips. The functional teeth are reduced to a pair of upper incisors (tusks in the males), and there are 4–6 other, peg-like teeth, the lower jaw having a horny pad. The stomach is complex, the intestine very long. Dugongs are distributed throughout coastal waters from the Red Sea to Taiwan and N. Australia. There is one genus (*Dugong*), and one species.

Duke of Argyll's tea-plant *See Lycium*.

Dulidae (palmchat; order Passeriformes) Monotypic family, comprising *Dulus dominicus*. It is an olive-brown bird with buff-white under-parts,

streaked with brown, a stout bill, and stout feet. It inhabits open country with palms, feeding on berries and blossom. Its nest is a large communal structure with separate entrances and nesting compartments, built high in a palm. It is found in the West Indies, confined to Hispaniola and Gonave.

dulosis (adj. dulotic) The slave-making behaviour of certain parasitic ant species, in which the workers raid nests of other species and remove pupae. These are then reared as slaves in the nest of the dulotic ant species, and pass on foraged food to their captors.

dulse Common name for the red seaweed *Palmaria palmata* (formerly *Rhodymenia palmata*). The thallus is flattened and usually dichotomously branched; it grows in the intertidal zone and at low-water mark, attached to rocks or to other seaweeds by a discoid holdfast. It has been used widely as food, although it is reputed to be tough and somewhat flavourless. *See also* pepper dulse.

Dulus dominicus (palmchat) *See* Dulidae.

dun *See* Ephemeroptera; and subimago.

dune Land-form produced by the action of a moving fluid (air or water) on unconsolidated sediment, normally sand. Aeolian dune forms range from small ripples less than 1 cm in height, to the draa forms of the Sahara which rise to 300 m. Dunes may be divided into three basic categories: barchans; longitudinal or 'seif' dunes, which parallel the wind direction; and transverse dunes which are aligned normally to the dominant wind. Transverse dunes are initial forms on sandy coastlines in temperate regions. They migrate inland and may be eroded locally by the wind to form a damp hollow or 'dune slack'. The enclosing crescentic dune is a 'parabolic' dune whose form reverses that of the barchan.

dune bedform ('megaripples') Mounds or ridges of sand which are asymmetrical, and are produced subaqueously by flowing water. The external morphology is similar to the smaller 'ripple' and larger 'sandwave', with a gently sloping, upstream side (stoss), and a steeper downstream side (lee). The crestline elongation extends transverse to the flow direction and is sinuous or lunate in plan. The height varies between 0.1 m and 2 m, while the wavelength (spacing) between dunes is 1–10 m. Size and growth are limited by water depth and, in general, dune height is less than one-sixth of the flow depth. The down-current migration of dune bedforms leads to the formation of crossbedding in sediments.

dune slack Flat-bottomed, hollow zone within a sand-dune system that has developed over impervious strata. The slack may result from erosion or blow-out of the dune system, and the flat base level is therefore close to or at the permanent water-table level. Characteristically, dune slacks have rich, marshy flora, with *Salix* species (willows) as typical woody colonizers. *See also* dune.

dung beetle *See* Geotrupidae.

dung roller *See* Scarabaeidae.

dunite Coarse-grained, igneous rock, consisting mainly of olivine. It was first described from the Dun Mountain Range, New Zealand.

dunnock (*Prunella modularis*) *See* Prunellidae.

duodenum In vertebrates, the section of the alimentary canal immediately behind the stomach, forming the start of the intestine.

duplication Chromosomal aberration in which more than one copy of a particular chromosomal segment is produced within a chromosome set.

duplicatus From the Latin *duplicatus* meaning 'doubled', a type of cloud with overlapping layers, typified by such genera as stratocumulus, altocumulus, altostratus, cirrostratus, and cirrus. *See also* cloud classification.

Duplicidentata *See* Lagomorpha.

duplicidentate In Lagomorpha, applied to the condition in which the first incisors are large and have persistent pulps, and the second are small, peg-like, and situated behind the first.

duplivincular Applied to a ligament formed from alternate bands of hard and soft tissue.

duricrust Deposit of the weathering zone, especially in subtropical environments, which may ultimately develop into a hardened mass. A range of types occurs, each distinguished by a dominant mineral: ferricrete and alcrete are dominated by sesquioxides of iron and aluminium respectively; silcrete by silica; and calcrete (caliche) by calcium carbonate.

du Rietz, G. E. Swedish ecologist who founded the Uppsala school of phytosociology.

Durio (family Bombacaceae) Genus of rainforest trees whose slender parts are covered with peltate scales. The flowers have numerous stamens, are often cauliflorous or ramiflorous, and are probably all bat-pollinated. The fruit is a big, woody, spiny capsule. The seeds are prominently arillate. *D. zibethinus*, cultivated for its creamy, pungent arils, arouses strong passions and 'is worth a trip to the east' (A. R. Wallace). There are 28 species occurring from Burma to the Philippines.

duripan Mineral diagnostic soil horizon which is cemented by silica and so will not slake or fall apart in water or hydrochloric acid. It may contain secondary cement, e.g. carbonates and iron oxide. Where duripans are exposed on the soil surface, they are called duricrust. *Compare* caliche.

Dusicyon (South American fox) *See* Canidae.

dusky cockroach (*Ectobius lapponicus*) *See Ectobius*.

dusky flathead (*Platycephalus fuscus*) *See* Platycephalidae.

dusky morwong (*Dactylophora nigricans*) *See* Cheilodactylidae.

dust devil (dust whirl, sand pillar) Very localized whirlwind in a desert area, where strong convection uplifts dust and sand often to a height of a few tens of metres.

dust whirl *See* dust devil.

Dutch elm disease Devastating disease which can affect all species of elm (*Ulmus*). The causal agent is *Ceratocystis ulmi*, a fungus which appears to have originated in Asia, not Holland. Symptoms include wilting, with curling and yellowing of foliage, followed by rapid death of branches or the whole tree. The fungus is spread from tree to tree by elm-bark beetles (*Scolytus*). In the 1960s a new and more virulent strain of the pathogen was introduced into Britain on logs imported from Canada; since then many millions of elms have been killed, dramatically changing the landscape in many regions of Britain. *See also* Scolytidae.

Dutchman's breeches (*Dicentra cucullaria*) *See Dicentra*.

Dutchman's pipe (*Aristolochia*) *See* Aristolochiaceae.

dwarf crocodiles *See* Crocodylidae.

dwarf emu (*Dromaius diemenianus*) *See Dromaius*.

dwarf lemur (*Cheirogaleus*) *See* Cheirogaleidae.

dwarf rasbora (*Rasbora maculata*) *See* Cyprinidae.

dyad In genetics, one of the products of the disjunction of the tetrads at the first meiotic division, contained in the nuclei of secondary gametocytes.

Dyera (jelutong; family Apocynaceae) Genus of giant forest trees whose trunks are tapped for white latex, now used solely for chewing gum. They yield pale, light, close-grained, useful timber. There are two species, occurring in W. Malesia.

dyke (dike) Discordant, or cross-cutting, tabular intrusion. Most are vertical or near vertical, having thrust their way through the overlying country rock. Dyke swarms are known and are often characterized by a parallel pattern.

dynamic equilibrium *See* equilibrium.

Dysdercus (cotton stainers) *See* Pyrrhocoridae.

dysentery Any condition of humans or other animals in which there is severe diarrhoea with blood and mucus in the stools. There are many possible causes. Common bacterial agents include species of *Shigella* (which causes 'bacillary dysentery'); dysentery can also be caused by certain protozoa, e.g. *Entamoeba histolytica*.

dysgenic Genetically deleterious.

dysodont Applied to a type of hinge dentition, found in certain pelecypods, where teeth are simple, small, and situated very close to the dorsal margins of the valves.

Dysommidae (arrowtooth eels; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of eel-like fish which have a scaleless body, small pectorals, and a row of strong teeth on the upper jaw. Possibly they live near the edge of the continental shelves.

Dysoxylum (family Meliaceae) Genus of trees or treelets, most of which occur in lowland rain forest. A few attain timber size. The leaves are pinnate; the flowers bisexual, or functionally unisexual. The fruit is a leathery capsule. There are few seeds; each has a fleshy jacket. There are 60 species, occurring from Indo-Malaysia to Melanesia, with one species in New Zealand.

dysphotic zone The region of the photic zone that lies below the compensation level, and within which light penetration is such that oxygen production by photosynthesis is exceeded by oxygen consumption by respiration. *Compare* euphotic zone.

dystrophic Applied to a lake that has become so shallow (through organic and inorganic sedimentation) and so depleted of oxygen (through the aerobic bacterial decomposition of the organic matter), that bog begins to form and peat to develop. A dystrophic lake may be regarded as the post-eutrophic stage in the transitional sequence, over geological time, of lake sedimentation, productivity, and maturity. These sequential phases are termed oligotrophic, mesotrophic, eutrophic, and dystrophic.

Dytiscidae (true water beetles, diving beetles; class Insecta, order Coleoptera) Family of large, shiny beetles up to 38 mm long, in which the dorsal and ventral surfaces are equally convex. Air is trapped between the elytra and abdomen for breathing under water. The hind legs are flattened and paddle-like, and specialized for swimming. Segments of the male fore tarsi are expanded to form suckers which hold the female during mating. The antennae are thread-like. Larvae are aquatic, with an elongate body, well-developed legs, and large, sickle-shaped mandibles. Adults and larvae are predatory on small fish, snails, and tadpoles. There are 4000 species.

dzhalman (*Selevinia*) *See* Seleviniidae.

E

eagle owl *See Bubo*.

eagle ray *See* Myliobatidae.

eagles 1 *See* Accipitridae; *Aquila*; and Falconiformes. 2 (fish eagles) *See Haliaeetus*. 3 (hawk eagles) *See Spizaetus*.

eaglewood (aloeswood) *See Aquilaria*.

earless monitor (*Lanthanotus borneensis*) *See* Lanthanotidae.

ear-stone (otolith) Generally oval-shaped, solid, calcareous structure enclosed in membranaceous sacs in the inner-ear region of the brain of vertebrates. Although there are usually three ear-stones on each side of the brain, the middle one, the sagitta, is often the largest. Because the ear-stone shows growth zones, or annual rings, it is used by fish biologists to determine the age of fish.

earth ball Common name for the spherical fruit body formed by species of *Scleroderma*. *S. aurantium* and *S. verrucosum* are common on the ground in woodland and heathland, and may form mycorrhizal associations with trees such as birch and pine.

earth fan *See Thelephora*.

earthflow Flow of unconsolidated material down a hillslope, normally resulting from an increase in pore-water pressure, which reduces the friction between particles. Flow velocities vary from slow, when behaviour is plastic, to rapid, when behaviour is more liquid, and reflect variations in water content. Dry flows may occur, as in China, when an earthquake shock breaks intergranular bonds.

earth measurers *See* Geometridae.

earth star Common name for a fruit body formed by species of the fungus *Geastrum*. The exoperidium (outer layer) splits and peels back from the endoperidium (inner layer) to give a star-shaped structure. *Geastrum* is found on the ground, e.g. in woods, sand-dunes, etc.

earth tongue Common name for the fruit body formed by fungi of the family Geoglossaceae.

earwigs *See* Dermaptera; Pygidicranidae; Labiduridae; Forficulidae; Apachyidae; Labiidae; Arixeniidae; and Hemimeridae.

East African pencil cedar *See Juniperus procera*.

East African steppe floral region Part of Good's (1974) African subkingdom, which lies within his Palaeotropical kingdom. The flora includes about 150 endemic genera, nearly all of which are small. They include *Saintpaulia*, one species of which, *S. ionantha*, is now a popular house plant.

East Australian current Oceanic water current that flows along the east coast of Australia. This strong, narrow (100–200 km wide) current forms the westerly part of the anticyclonic circulation in the S. Pacific. The flow velocity varies in the range 0.3–0.5 m/s. It is an example of a western boundary current.

East Australian hairtail (*Trichiurus savala*) *See* Trichiuridae.

east coast fever *See Theileria*.

easterly wave Type of weak trough in a tropical easterly airflow, which has a wavelength generally of 2000–4000 km. Such waves occur, for example, over W. Africa and in the Caribbean area where they develop in summer and autumn with a weak or absent trade-wind inversion, and in the central Pacific, when the equatorial trough is displaced northward. Disturbances in such waves often lead to tropical storms, which vary in intensity.

eastern box turtle *See Terrapene carolina*.

East Indian arrowroot *See Tacca*; and Taccaceae.

ebb tide Falling tide: there is a lowering of the water level and a general movement of water seawards. It marks the period between high water and the succeeding low water. *Compare* flood tide.

Ebenaceae Family of mainly tropical trees in which the leaves are simple, without stipules. The flowers are usually unisexual. They have fused sepals and petals; and epipetalous stamens. The ovary is usually superior. The fruit is a berry. There are two genera, with 400–500 species, centred on the Indo-Malaysian rain forests, in which there are 200 species.

ebony *See Diospyros*.

EB virus *See* Epstein–Barr virus.

Ecardines Alternative name for the class Inarticulata of the phylum Brachiopoda.

ecdysis Periodic shedding of the exoskeleton by some invertebrates, or of the outer skin by some Amphibia and Reptilia.

ecdysone Hormone produced by the prothoracid glands which brings about moulting in an insect. The form of the animal after each moult is determined by the juvenile hormone. Ecdysone acts mainly on the epithelial cells.

ecesis The ability of some migrating plant species, having arrived at a new site, to germinate, grow, and reproduce successfully, while others fail to become established in the new environment. It represents the third in a series of six phases in plant succession.

Echeneidae (remora; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which are distinguished by the presence of a flat disc-like structure on top of the head.

Actually a highly modified spinous dorsal fin, this is used by the fish as a sucking disc; by means of it the remora attaches itself to the bodies of larger fish, e.g. sharks and marlins. In the past, fishermen reputedly used remoras with lines fastened to their tails in order catch turtles and large fish. One of the larger species, *Remora remora*, may reach a length of 90 cm.

echidna (*Tachyglossus*) *See* Tachyglossidae.

Echimyidae (spiny rats; order Rodentia, suborder Hystricomorpha) Family of ground-dwelling, burrowing rodents, some of which are arboreal, and others semi-aquatic. The legs are long. The first digit of the forelimb is rudimentary, the hind limb pentadactyl. The hair tends to be spiny. Echimyidae are distributed throughout tropical S. America. There are 14 genera, with about 43 species.

Echinacea (class Echinoidea) Superorder of regular echinoids with rigid tests, gill slits, complete perignathic girdles, and keeled teeth. They first appeared in the Upper Triassic.

Echinocystitoida (subclass Perischoechinoidea) Extinct order of Palaeozoic regular echinoids, with strongly imbricating plates and lacking a perignathic girdle. About 25 genera are known.

Echinodermata Phylum of 'spiny-skinned' invertebrate animals which are entirely marine. They are characterized by an internal, mesodermal skeleton of porous calcite plates; a pentameral symmetry (although a bilateral symmetry is often superimposed upon this radial plan, especially in many modern echinoids); and the presence of a water-based vascular system, a complex internal apparatus of fluid-containing tubes and bladders which pass through pores in the skeleton and are seen from the outside as tube-feet. The phylum is varied, and includes Ophiuroidea (brittle-stars), Asteroidea (starfish), Echinoidea (sea-urchins), Holothuroidea (sea-cucumbers), and Crinoidea (sea-lilies); and the extinct Edrioasteroidea, Blastoidea, Carpoidea, and Cystoidea. *Tribrachidium* from the late Precambrian of Australia is probably an echinoderm, close to the stock from which the other groups evolved in the Cambrian and Ordovician. Echinoderms first appeared in the Lower Cambrian, but of the 20 classes known in the Palaeozoic, only six survive into the Mesozoic and on to the present day.

Echinoida (superorder Echinacea) Order of regular echinoids with imperforate, non-crenulate tubercles, solid spines, and shallow gill slits. They first appeared in the mid-Cretaceous.

Echinoidea (sea-urchins, sand-dollars, heart-urchins; phylum Echinodermata, subphylum Echinozoa) Class of free-living echinoderms in which the body is enclosed in a globular, cushion-shaped, discoidal, or heart-shaped test built of meridionally arranged columns of interlocking, calcareous plates, which bear movable appendages (spines, pedicellariae, and spheridia). The test is composed of 20 vertical rows of plates arranged in five double rows of perforate (ambulacral) plates and five double rows of imperforate (interambulacral) plates. Tube-feet, connected to the internal water-based vascular system, emerge through the pores of the ambulacra. The apical system on the upper surface consists of five ocular plates and up to five genital plates. In all regular echinoids the anus is enclosed within the apical system, but in many irregular echinoids it is in the posterior interambulacrum. The mouth is always on the lower surface and may be central or anterior in position. The class first appeared in the Ordovician; underwent a great adaptive radiation in post-Palaeozoic times, when rigid tests were evolved; experienced a marked reduction in the Permian and Triassic; and thereafter resumed its diversification, which has continued until the present day. Fossils of the inner skeletons of these echinoderms are common in both Mesozoic and Cenozoic sediments. There are about 125 Palaeozoic, 3670 Mesozoic, 3250 Cainozoic, and more than 900 extant species.

Echinophthiriidae (order Phthiraptera, suborder Anoplura) Family of sucking lice which are parasitic on seals and otters. Species differ from other Anoplura in the lack of eyes or ocular points; the lack of abdominal sclerites; the thick covering of setae; and the long, tubular, spiracular chamber. They are the only lice to parasitize marine mammals, and some species are known to obtain oxygen from sea-water by cutaneous respiration. This is possible because the cuticle is very thin, and such lice are thickly covered in protective, flattened scales. Some species of seal lice live in the nasal passages of the host, while others burrow a short distance into the skin. Many seals come to land only once a year, to breed, and the life cycle of the lice is synchronized to this and they breed at the same time as the seals. It is then that lice are able to move from seal to seal, and to colonize young seals. There are five genera, with 12 species.

echinopluteus larva In Echinodermata, a larval form possessing limb-like outgrowths bearing ciliated bands.

Echinops (globe thistle; family Compositae) Genus of plants with a thistle-like habit and globular heads of flowers 4–6 cm wide, the individual flowers each having an involucre of bristle-like bracts. They are grown for their unusual, blue flower heads. They occur in C. and S. Europe, and W. Asia.

Echinosorex gymnurus (gymnure, Malayan moon rat) *See* Erinaceoidea.

Echinothurioida (superorder Diadematacea) Order of regular echinoids with flexible tests and compound ambulacral plates bearing three pore pairs. The tubercles are non-crenulate. At the present day there are many abyssal forms. They first appeared in the Upper Jurassic.

Echinozoa (phylum Echinodermata) Subphylum whose members have radial symmetry of a globoid body without arms or projecting rays. It contains seven classes in the Palaeozoic, but only two of these (Echinoidea and Holothuroidea) survive to the present day.

echinulate Covered with small points or spines.

Echiurida Phylum of coelomate worms in which mature individuals lack body segmentation. Parapodia are absent in most forms. All have a pharynx, and most possess a proboscis. The nervous system is present, but sense organs are absent. Males and females occur. They are exclusively marine, and most are burrowers.

echiurus larva In Sipunculida, a trochophore larva.

Echmatocrinea (class Crinoidea) Order of primitive pelmatozoan echinoderms known only from the Middle Cambrian. They have an irregularly plated calyx, and no stem, being attached by an irregular holdfast. There are 8–10 short, uniserial arms. Some authorities exclude this group from the crinoids.

echo-location Detection of an object by means of reflected sound. It is used by bats, by some cetaceans, and by other animals for purposes of orientation and to find prey.

echoviruses Group of viruses belonging to the Picornaviridae; they were originally believed not to cause disease, but are now known to cause various mild or severe diseases of the central nervous system, respiratory tract, and intestinal tract.

eclogite Very rare, coarse-grained, igneous rock with a chemical composition similar to that of basalt, but noted for the presence of the rare, bright-green pyroxene omphacite, and red, almandine-pyrope garnets. Eclogites may be basalt altered by high temperatures and pressures.

ecocline (ecological gradient) The rate of ecological change in ecosystems; it is the joint expression of associated community (coenocline) and complex environmental gradients.

ecoe *See* density measure.

ecological amplitude Range of tolerance of a species, diagrammatically forming a bell-shaped curve. Species with a narrow ecological amplitude often form good indicator species.

ecological and phytosociological distance (*D*) *See* affinity index.

ecological backlash Unexpected and detrimental consequences of an environmental modification (e.g. dam construction) which may outweigh the gains anticipated from the modification scheme.

ecological barrier *See* dispersal barrier.

ecological efficiency The ratio between energy flows measured at different points in a food-chain, usually expressed as a percentage. Many approaches have been devised to relate different aspects, e.g. intake, assimilation, and production. Two main categories of efficiencies are studied: (a) those of energy transfer between different trophic levels; and (b) those of energy transfer within a single trophic level.

ecological energetics The study of energy transformations within ecosystems.

ecological evaluation Assessment of the ecological qualities of an area with a view to determining its future use. It is used most especially as a means of identifying sites that are potentially important for nature conservation. No single, universally acceptable scheme has yet been devised.

ecological factor *See* limiting factor.

ecological genetics The study of genetics with particular reference to variation on a global and local geographic scale.

ecological gradient *See* ecocline.

ecological indicator Any organism or group of organisms indicative of a particular environment or set of environmental conditions. For example, lichens may be used as indicators of air pollution; and fossil assemblages as indicators of past environments. *See also* indicator species.

ecological isolation Separation of groups of organisms as a result of changes in their ecology or in the environment in which they live. This is one of the processes leading to speciation, since there will be a restriction in the movement of genes between groups thus separated, and changes in gene frequencies may occur due to local selection or drift until eventually the groups may be so divergent that reproductive barriers exist.

ecological niche *See* niche.

ecological pyramid (Eltonian pyramid) Graphical representation of the trophic structure and function of an ecosystem. The first trophic level, of producer organisms (usually green plants), forms the base of the pyramid, with succeeding levels added above to the apex. There are three types of pyramids: of numbers, of biomass, and of energy. The alternative name for the concept is taken from the name of Charles Elton, the British ecologist who devised it.

ecological succession *See* succession.

ecological system *See* ecosystem.

ecology The scientific study of the interrelationships among organisms and between organisms, and all aspects, living and non-living, of their environment. Ernst Heinrich Haeckel (1834–1919) is usually credited with having coined the word 'ecology' in 1869, deriving it from the Greek *oikos*, meaning 'house' or 'dwelling place'.

eco-organ Term used in some modern attempts to devise a system for describing vegetation types on the basis of life-form rather than species composition. An eco-organ is a characteristic morphological feature which reflects adaptation to external environmental conditions. Sunken stomata are one example; narrow, needle, or divided leaves are another. *Compare* life-form; and Raunkiaer.

ecosphere *See* biosphere.

ecosystem (ecological system) Term first used by A. G. Tansley (1935) to describe the interdependence of species in the living world (the biome or community) with one another and with their non-living (abiotic) environment. Fundamental concepts include the flow of energy via food-chains and food-webs, and the cycling of nutrients biogeochemically. Ecosystem principles can be applied at all scales—thus principles that apply to an ephemeral pond, for example, apply equally to

a lake, an ocean, or the whole planet. In Soviet and central European literature 'biogeocoenosis' describes the same concept.

ecotone Narrow and fairly sharply defined transition zone between two or more different communities. Such edge communities are typically species-rich. Ecotones arise naturally, e.g. at land–water interfaces; but elsewhere may often reflect human intervention, e.g. the agricultural clearance of formerly forested areas.

ecotope The habitat component of a biogeocoenosis.

ecotype Locally adapted population of a widespread species. Such populations show minor changes of morphology and/or physiology, which are related to habitat and are genetically induced. Nevertheless they can still reproduce with other ecotypes of the same species. Heavy-metal-tolerant ecotypes of common grasses such as *Agrostis tenuis* are an example.

Ectobius (class Insecta, order Blattodea) Genus of cockroaches which are relatively small, generally ground-dwelling, and found in woodland, heathland, and grassland. The genus includes *E. lapponicus* (dusky cockroach), *E. pallidus* (tawny cockroach), and *E. panzeri* (lesser cockroach). The genus is native to Europe, including S. England.

Ectocarpales (class Phaeophyceae) Order of brown seaweeds in which the thallus is usually composed of two parts: a prostrate disc which functions as a holdfast, and an erect thallus which may be filamentous, foliose, or bulbous. There are many families. They are found mainly in the intertidal zone, attached to rocks or to other seaweeds.

ectocrine (environmental hormone, exocrine) A chemical substance, released by an organism into the environment during decomposition processes, which influences the activity of another organism.

ectoderm In an animal embryo, the layer of cells that gives rise to nerve tissue, nephridia, and the epidermis. *See also* gastrulation.

Ectognatha In some classifications, a superorder of insects comprising the ectognathous groups Pterygota and Thysanura.

ectognathous Of insect mouthparts, well developed and projecting outwards from the head rather than being contained in an eversible pocket.

ectomycorrhiza Type of mycorrhiza in which the fungal hyphae do not penetrate the cells of the root, but cover the root and grow between the root cells. This type of mycorrhiza is common in forest trees.

ectoparasite *See* parasitism.

Ectopistes migratorius (passenger pigeon) *See* Columbidae.

ectoplasm In plant cells and some Protozoa, the outer, gel-like layer of the cell cytoplasm, which lies immediately beneath the cell membrane and contains packed layers of microtubules.

Ectoprocta **1** (phylum Bryozoa) The major subphylum of bryozoans, in which the lophophore surrounds the mouth but not the anus (in contrast to the Entoprocta). Many possess a calcite skeleton. Ectoprocts are mostly, but not exclusively, marine, and have an extensive fossil record from the Ordovician to the present. **2** Alternative name for Bryozoa.

edaphic Of the soil, or influenced by the soil.

edaphotope The soil component of the ecotope (habitat) of a biogeocoenosis.

eddy Motion of air in directions differing from, and at some points contrary to, the direction of the larger-scale wind current. Eddies vary in size from small-scale turbulence (which can transport dust and diffuse pollutants) to large-scale movements (e.g. cyclone and anticyclone cells) within the general global circulation of the atmosphere.

edelweiss (*Leontopodium alpinum*) *See Leontopodium*.

Edentata (infraclass Eutheria, cohort Unguiculata) Order comprising two suborders, Palaeanodonta (which includes ancestral forms), and Xenarthra (the S. American ant-eaters, armadillos, and sloths). The teeth are reduced in number, have a simple peg-like form, and lack enamel; in the ant-eaters they are absent entirely, reflecting adaptation to a diet of invertebrates. The brain case is low, the brain small, the olfactory region large. There are extra articulations between the lumbar vertebrae. The feet have well-developed claws, used for digging or hanging, and some edentates walk on the outsides of the feet. Body temperatures tend to fluctuate widely with ambient air temperature. Edentates are considered to have departed little from the general eutherian form, their superficial features being adaptations to particular ways of life.

edentulous Applied to a condition found in some pelecypods in which hinge teeth are absent.

edible crab *See Cancer pagurus*.

edible frog *See Rana esculenta*.

Edrioasteroidea Extinct group of echinoderms with flexible tests, which probably lived attached to the sea-floor. They appeared in the Lower Cambrian and became extinct in the Lower Carboniferous.

eelblennies *See* Congrogadidae.

eel gobies *See* Gobioididae.

eelpout (*Zoarces viviparus*) *See* Zoarcidae.

eels **1** (arrowtooth eel) *See* Dysommidae. **2** (common eel, *Anguilla anguilla*) *See* Anguillidae. **3** (conger eel) *See* Congridae. **4** (cusk-eel) *See* Ophidiidae. **5** (cut-throat eel) *See* Synaphobranchidae. **6** (deep-sea eel) *See* Serrivomeridae. **7** (duckbill eel) *See* Nettastomidae. **8** (electric eel, *Electrophorus electricus*) *See* electric fish; and Electrophoridae. **9** (false moray eel) *See* Xenocongridae. **10** (knife eel) *See* Gymnotidae. **11** (longneck eel) *See* Derichthyidae. **12** (long-tailed eel, *Thyrsoidea macrura*) *See* Muraenidae. **13** (moray eel) *See* Muraenidae. **14** (pike conger eel) *See* Muraenesocidae. **15** (reef-eel, *Thyrsoidea macrura*) *See* Muraenidae. **16** (rice eel, *Monopterus alba*) *See* Synbranchidae. **17** (shrimp eel, *Ophichthus gomesi*)

See Ophichthidae. **18** (snake eel) *See* Ophichthidae. **19** (snipe eel) *See* Nemichthyidae. **20** (spiny eel) *See* Mastacembelidae; and Notacanthidae. **21** (swamp eel) *See* Synbranchidae. **22** (witch eel) *See* Nettastomidae. **23** (worm eel) *See* Mormyridae.

eelworms *See* Nematoda.

effective population size Average number of individuals in a population that actually contribute genes to succeeding generations. This number is generally rather lower than the observed, censused, population size, being reduced by the following factors: (a) a higher proportion of one sex may mate; (b) some individuals will pass on more genes by having more offspring in a lifetime than others; (c) any severe past reduction in population size may result in the random loss of particular genotypes.

effective precipitation Net precipitation after losses by evaporation. As higher temperatures increase evaporation, an index of effective precipitation derived from a temperature–precipitation ratio has been used as a criterion for some systems of climate classification (Köppen in 1936, Thornthwaite in 1948).

effective temperature (T_e) The temperature of a planetary surface in the absence of an atmosphere. The effective temperature of Earth is some 35–40 °C lower than the actual Earth surface temperature (T_s): the latter is approximately 15 °C owing to the greenhouse effect of the Earth's atmosphere.

effused Loosely or irregularly spreading.

effused-reflexed Of a fungal fruit body, for example: flat and spreading except at the edges, which grow outwards from the substratum.

eggars *See* Lasiocampidae.

egg burster Spine or tooth on the surface of the cuticle of the first instar larva of an insect, which allows it to break out of the egg.

egg-eating snakes (order Squamata, suborder Serpentes (Ophidia), family Colubridae) Two genera of snakes, *Dasypeltis* from Africa and *Elachistodon* from India, which feed almost exclusively on eggs. Elongate projections from the neck vertebrae pierce the throat, and with throat-muscle action break the egg-shell, which is regurgitated.

egg-raft *See Culex fatigans*.

egg wrack (knotted wrack) Common name for the brown seaweed *Ascophyllum nodosum*. The thallus is flattened and strap-like, branching, with no midrib; there are large, single air bladders. It is found in the middle part of sheltered rocky shores, often in great abundance. It may also be found in salt-water lochs.

egrets *See Egretta*.

Egretta (egrets, herons; family Ardeidae) Genus of medium to large, long-necked, long-legged herons with well-developed head, neck, and back plumes. Many occur in colour phases varying from white to black. They inhabit marshes and lakes, feeding on fish, frogs, and other aquatic animals, and nesting in trees. There are 13 species, found worldwide.

EIA *See* environmental-impact assessment.

Eichhornia (family Pontederiaceae) Genus of herbs. *E. crassipes* is the water hyacinth, a floating plant with bladder-like swollen petioles and a noxious weed in many parts of the tropics. There are seven species occurring in warm and tropical America.

eiders *See Somateria*.

Eifelian *See* Devonian.

Eigenmannia virescens (green knifefish) *See* Rhamphichthyidae.

eigenvalue (latent root, λ) In principal components analysis, the components or latent roots derived from the data that represent that variation in the original data accounted for by each new component or axis.

eigenvector (latent vector) In principal components analysis, the loading of an attribute or variable on a component, as measured by the correlation between the original variable and the new component.

Eimeriina (order Eucoccidia) Suborder of protozoa in which syzygy does not occur. They are parasitic, growing inside the cells of a wide range of vertebrate and invertebrate hosts, and are commonly parasitic in domestic animals. The suborder includes some pathogens. There are several families, and many species.

Ekman spiral Theoretical model to explain the currents that would result from a steady wind dragging over an ocean of unlimited depth and extent, and of uniform viscosity. In the northern hemisphere the surface layer of the water would flow at an angle of 45° to the right of the wind direction. Water at increasing depths would drift in directions more to the right, until, at about 100 m depth, the water would move in a direction opposite to that of the wind. The velocity of the water flow decreases with depth throughout the spiral. In the northern hemisphere, the net water transport is at 90° to the right of the wind direction.

Elachistodon *See* egg-eating snake.

Elaeagnaceae Family of shrubs in which the leaves are covered densely with scale-like hairs, giving them a silvery appearance. The flowers are tiny, solitary, or clustered, with two or four sepals. The fruit is drupe-like. They are often cultivated for their foliage. There are three genera, with about 30 species, found in northern temperate and tropical regions.

Elaeis (oil palm; family Palmae) Genus of stout, solitary palms which have persistent leaf-bases, and a crown of numerous, large, pinnate leaves. They are monoecious. There are dense, axillary, separate male and female inflorescences. The fruits have an oily, fleshy-fibrous mesocarp; and a stony endocarp (stone) with three apical pores, containing one seed, which has an oily endosperm. There are two species, one found in Africa, and one in northern S. America. The former, *E. guineensis*, is now cultivated extensively as one of the world's major sources of vegetable oil.

Elaenia (elaenias; family Tyrannidae) Genus of tyrant flycatchers, olive in colour with paler under-parts and two well-marked wingbars. The head is slightly crested with a concealed white crown patch. Elaenias are arboreal and insectivorous, and build neat, open-cupped nests in trees. There are 17 species, all difficult to distinguish, found in C. and S. America and the West Indies.

Elaeocarpaceae Family of tropical and subtropical trees and shrubs in which the leaves are opposite or alternate, with stipules. The flowers have four or five free sepals and petals. The petals are often frilled, or absent. There is a disc with many stamens, and anthers with pores. The ovary is superior. The fruit is a capsule or drupe. There are 12 genera, with 350 species.

Elaeocarpus (family Elaeocarpaceae) Genus of trees whose fruit is a drupe, which in some species is edible. There are 200 species, occurring from E. Asia to the Pacific islands.

eland (*Taurotragus oryx*) *See* Bovidae.

Elanus (kites; family Accipitridae) Genus of small grey and white hawks with black wing markings and ungrooved talons. They inhabit open country, hovering for insects and small mammals, and nesting in trees. There are three or four species, found in Europe, Africa, S. Asia, Australia, and the Americas.

Elaphe longissima (Aesculapian snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snakes, which grow to 2 m long. They are brown or yellow-grey, stippled with white, and feed mainly on rodents. The female lays 5–20 eggs. *E. longissima* inhabits dry, deciduous woods and shrubberies in C. and S. Europe.

Elaphe quatuorlineata (four-lined snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of large, thick-set snakes, which grow to 2.5 m long. Adults typically have four dark dorsal stripes; blotched specimens occur in the east of the snake's range, which extends from Italy to SW USSR and Iran.

Elaphe situla (leopard snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snakes which can attain 1 m in length. They are yellowish, or greyish, with large red or brown blotches on the back. The snake occurs in S. Italy, the Balkans, the Crimea, and SW Asia, notably in stony, scrubby localities.

Elapidae (cobras, kraits, mambas, coral snakes; order Squamata, suborder Serpentes (Ophidia) Family of venomous snakes, which have short, firm, grooved fangs at the front of the mouth. The venom is mainly neurotoxic (a nerve poison). Generally these are elongate, agile snakes, active at dusk or dark. Their prey consists mainly of small vertebrates. There are about 200 species, found in every continent except Europe. *See also Ophiophagus hannah*.

Elasipodida (subclass Aspidochirotacea) Order of deep-water holothuroids which lack respiratory trees, gas exchange occurring through the body surface.

Elasmobranchii Subclass of shark-like fish. They have 5–7 gill slits, fairly rigid fins, placoid scales, a spiracular opening behind the jaws, numerous teeth, and claspers on the ventral fins of the male. Modern elasmobranchs have a cartilaginous skeleton. Apart from modern sharks and rays, the subclass also includes many fossil species.

Elassoma zonatum (banded pygmy sunfish) *See* Centrarchidae.

elastic growth The part of cell-wall extension that is reversible.

elater Type of spirally-thickened cell found among the spores in the capsules of liverworts. Elaters are hygroscopic, changing shape with changes in moisture, and aid in the dispersal of the spores.

Elateridae (click beetles, skip-jacks, snapping beetles; class Insecta, order Coleoptera) Family of elongate, usually black or brown beetles, 3–54 mm long, with long, often comb-like antennae. If the beetle falls on its dorsal surface, the body jack-knifes with a pronounced click, throwing it into the air, and thus turning it over, so that it may land on its ventral surface. The larvae (wireworms) are long, cylindrical, and tough-skinned; they can be serious crop pests, feeding on roots. Others are carnivorous or wood-feeders. *Pyrophorus* species (fireflies) occur in the neotropics: all stages are luminescent (*compare* Lampyridae). There are 7000 species, with very wide distribution.

Elateriospermum Genus of one species, *E. tapos*, a rainforest tree whose fruit is a big, bony capsule. The seeds are edible after boiling or roasting, and are collected but never cultivated. The hard, heavy timber is good for firewood and heavy construction. It occurs in the Malay peninsula, Sumatra, and Borneo.

Elatinaceae Family of small, aquatic or marsh herbs in which the leaves are opposite or in whorls, and simple, with stipules. The tiny flowers are solitary or clustered in the leaf axils, with 3–5 imbricate sepals and petals, and with twice as many stamens as petals. There are two genera, with about 40 species, with a cosmopolitan distribution.

elbow of capture *See* river capture.

elder *See Sambucus*.

electric catfish (*Malapterus electricus*) *See* Malapteruridae.

electric eel (*Electrophorus electricus*) *See* Electrophoridae; and electric fish.

electric fish Number of species of different families are capable of generating electric discharges. Some, e.g. *Electrophorus electricus* (electric eel) and the electric rays (e.g. the Atlantic *Torpedo nobiliana*), can produce strong, stunning currents capable of immobilizing potential prey. The electric organs are derived from muscle tissue which is organized as a series of units, each one acting as a type of battery. The electric eel (which is related to the carp, not to the true eel) also uses the electrical pulses as a navigational aid, as do the African elephantfish (Mormyridae).

electric ray *See* Torpedinidae.

electrode potential *See* reduction potential.

electromagnetic sense Mechanism by which some fish—e.g. *Scyliorhinus* (dogfish)—and many invertebrates are able to orientate themselves within an electric field that they themselves generate, or by disturbances that they detect in the Earth's electrical or magnetic fields. In some fish the electric pulses are altered by individuals to prevent interference with neighbours, and are used as a means of communication.

electron carrier Compound that functions as an acceptor and donor of electrons and/or protons in an electron-transport system.

electron-transport chain 1 Respiratory chain. A system of redox compounds called electron carriers, present in mitochondria, which sequentially transport electrons and/or protons previously removed from metabolites in glycolysis, the citric-acid cycle, and other metabolic reactions. 2 A system of redox compounds involved in electron transport in metabolic pathways such as photosynthesis.

electrophoresis Migration under the influence of an electric field of charged particles within a stationary liquid. The latter may be a normal solution or held upon a porous medium, e.g. starch, acrylamide gel, or cellulose acetate. The rate at which migration occurs varies according to the charge on the particle and also its size and shape. The phenomenon is exploited in a variety of analytical and preparative techniques employed in studies of macromolecules.

Electrophoridae (electric eel; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) A monospecific family comprising *Electrophorus electricus* (electric eel). It has an elongate, eel-like body with a long anal fin confluent with the tail-fin. There are no scales, and the dorsal fin is absent. The long tail region contains the specialized muscles that form the electric organ, which is capable of producing about 600 volts per discharge. It is found only in the Amazon and Orinoco rivers of S. America. *See also* electric fish.

Electrophorus electricus (electric eel) *See* Electrophoridae; and electric fish.

Elegatis bipinnulatus (rainbow runner) *See* Carangidae.

Eleiodoxa (family Palmae) Monotypic genus of spiny palms which form dense, extensive clumps in lowland swamp rain forest. They are similar to *Salacca*, but the inflorescences form a massive terminal head. The fruit pulp is sour. They occur in Malaya, Borneo, Banka, and Riouw.

elementary particles *See* cristae.

elements, crustal abundance of Oxygen constitutes almost 50% of the Earth's crust by weight and is the most abundant element. Other major elements include: silicon, which is the second most abundant, constituting 27.72% of the crust by weight; aluminium (third); sodium; magnesium; calcium; and iron. Other elements, including such desired metals as gold, silver and platinum, have only limited presence in the crust.

Eleocharis (family Cyperaceae, subfamily Scirpoideae) Genus of grass-like herbs, mainly perennial, with many flowered spikelets and creeping underground rhizomes. *E. tuberosus* is the Chinese water chestnut which is cultivated in China and Japan for its edible tubers. There are 200 species, distributed worldwide.

Eleocharis tuberosus (Chinese water chestnut) *See Eleocharis*.

Eleops saurus (ladyfish) *See* Elopidae.

Eleotridae (gudgeon, sleeper; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of small fish found in marine, brackish, and freshwater environments. Like the related gobies, they have a fairly round body, a blunt head with the eyes located almost above the jaws, two dorsal fins, and a rounded tail-fin. In contrast with the gobies, the ventral fins of the gudgeons are close to one another but do not form a sucking disc. One of the largest species is *Gobiomorus dormitor* (bigmouth sleeper) which grows to 60 cm; most do not exceed 20 cm. Some of the freshwater species, e.g. *Hypseleotris compressus* (carp gudgeon), 6 cm, of E. Australia, are used as colourful aquarium fish. There are about 150 species, distributed worldwide.

elephant 1 *See* Elephantidae; and Proboscidea. 2 (Asian elephant) *See Elephas*. 3 (African elephant) *See Loxodonta*.

elephant beetle *See* Scarabaeidae.

elephant birds *See* Aepyornithidae.

elephantfish *See* Callorhynchidae; and Mormyridae.

elephantiasis In humans, enlargement of the limbs or scrotum, often extreme, as a result of the obstruction of lymphatic channels by filarial worms (Nematoda, family Filariidae). The best-known causative species is *Wucheria bancrofti*, which is carried and transmitted by females of the mosquito *Culex fatigans* (order Diptera, family Culicidae).

Elephantidae (order Proboscidea, suborder Gomphotherioidea) Family comprising the ancestral and modern elephants, which can be traced back to the Miocene (*Stegolophodon*) and which is distinct from that of the superficially similar mastodons (Mammutidae). The incisors grow to tusks in the upper jaw only: other incisors and canines are absent. Three milk premolars and three molars are present: only one tooth in each half jaw is used at a time; it is shed when worn and replaced by the tooth behind it, which moves forward. The skull is short; the nasal aperture high in the face; the proboscis long and muscular, with nostrils at its end. The limbs end in short hoofs; the gait is digitigrade. The family is distributed throughout Africa south of the Sahara, and S. Asia. The family includes the extinct *Mammuthus* (mammoth) and the two surviving genera (*Elephas* and *Loxodonta*), with two species.

elephant louse (*Haematomyzus elephantis*) *See* Rhyncophthirina.

elephant shrew *See* Macroscelidea.

Elephas (Asian elephant; family Elephantidae) Genus of elephants in which the skull is short and deep, with a rounded vault, and the tusks are short, fairly straight, downward-pointing, and present only in males. *Elephas* are smaller than African elephants, and have smaller ears.

Eleutheronema tetradactylus (N. American giant threadfin, Cooktown salmon) *See* Polynemidae.

Eleutherozoa (phylum Echinodermata) Ranked previously as a subphylum; the term is used now only informally, to denote free-living echinoderms. These include the subphyla Asterozoa and Echinozoa, comprising the classes Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea.

elfin wood Open tract of dwarfed, gnarled trees on tropical mountains, growing above the forest proper, and forming a transition zone between this and the higher alpine vegetation of grasses and shrubs. The term is sometimes applied outside the tropics, although in this context it is more usual to apply the name 'kampfzone'.

elk 1 N. American form of *Cervus elaphus* (red deer, wapiti). 2 (moose, *Alces alces*) *See* Cervidae.

Ellesmeroceratida (class Cephalopoda, subclass Nautiloidea) Order of primitive, early cephalopods which are morphologically very varied. Often septa are closely spaced, the siphuncle is marginal, and septal necks are very short. Connecting rings may occur, and if they do they are moderately thick. The order ranges in age from Upper Cambrian to Lower Silurian.

elm-bark beetle (*Scolytus scolytus*) *See* Scolytidae.

Elmidae (class Insecta, order Coleoptera) Family of small beetles, 2–5 mm long, which have punctured elytra, and raised lines on the thorax. The antennae are filiform. The legs are long and slender, with an elongate terminal tarsal segment. They live in running water. Some breathe under water, using an air film trapped by hairs as a physical gill. Larvae are woodlouse-shaped, with terminal external gills, and are found clinging to stones or weeds in water. There are 300 species.

elms *See Ulmus*.

Elodea (frog-bit) *See* Hydrocharitaceae.

Elopidae (giant herring, ladyfish; class Osteichthyes, subclass Actinopterygii, order Elopiformes) Family of marine to estuarine fish, which have a very slender, silvery body; a single dorsal fin; small pectoral and pelvic fins; but a large, forked tail-fin. *Elops saurus* (ladyfish), 90 cm, often enters estuaries in small schools. It is a popular game fish in the W. Atlantic. Different species may exist in the Indo-Pacific region.

Elopiformes Order of marine bony fish, which have the pelvic fins in the abdominal position, opposite the single dorsal fin; wide gill openings; and a strongly forked tail-fin. The order includes the families Megalopidae (tarpon) and Elopidae (ladyfish).

Elopomorpha Superorder of bony fish which includes the orders Elopiformes, Anguilliformes, and Notacanthiformes.

Elops saurus (ladyfish) *See* Elopidae.

Eltonian pyramid *See* ecological pyramid.

eluviation Removal of soil materials in suspension or in solution from surface horizons, and with partial deposition in the lower horizons of soil profiles. Removal in solution is called leaching, and hence the term 'eluviation' is often limited in use to removal in suspension.

elver *See* Anguillidae.

elytron (pl. elytra) Hard, often coloured forewing of a beetle or earwig, which gives the animal its characteristic appearance (e.g. the colour and spots of a ladybird) when it is not flying.

emarginate Of a fungal gill: having a notch at the edge nearest the stipe.

Emballonuridae (sac-winged bats; order Chiroptera, suborder Microchiroptera) Family of bats, in many species of which a glandular sac is present in the propatagium in front of the arm. The third digit is elongated and folds twice (into an 'N' shape). The ears are separate, with a small tragus; the small tail projects from a loose sheath on the dorsal side of the uropatagium; and the nose is simple and pointed in many species. Sac-winged bats often roost in the open or in well-lit cave entrances. They are distributed throughout the New and Old World tropics. There are about 13 genera, with about 40 species.

Embden–Meyerhof pathway *See* glycolysis.

Emberiza (buntings; family Emberizidae) Genus of mainly brown, streaked birds, males often having striking coloured head patterns. They are usually found in open country, building an open nest, usually in trees or bushes; *E. striolata* (house bunting) prefers to occupy buildings. There are 38 species, found in Europe, Asia, and Africa.

Emberiza striolata (house bunting) *See Emberiza*.

Emberizidae (buntings, sparrows, finches; order Passeriformes) Family of small, mainly brown, streaked birds with medium-length feet, longish tails, and short conical bills. They inhabit open areas, grassland, and woodland, feeding mainly on seeds and building either an open or dome-shaped nest in trees or bushes, or on the ground. There are about 70 genera, with about 280 species, found in N., C., and S. America, Africa, Europe, and Asia.

Embiotocidae (surfperch; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of coastal marine fish, which have oval-shaped, compressed bodies, small mouths, and joined, spinous and soft-rayed dorsal fins. Many species are known to give birth to their young rather than lay eggs. *Rhacochilus toxotes* (rubberlip sea-perch) reaches a length of about 40 cm: the other 22 species are smaller. All are found in the N. Atlantic.

Emblica (family Euphorbiaceae) Genus of small trees, including *E. officinalis* (*Phyllanthus emblica*) which has edible fruit. There are four species, occurring in Madagascar and Indo-Malaysia.

Embrithopoda (cohort Ferungulata, superorder Paenungulata) Extinct order of subungulates of

uncertain ancestry and with no known descendants, known by one form, *Arsinoitherium*, from the Lower Oligocene of Egypt. The animal was the size of a rhinoceros, about 3.4 m long; possibly it dwelt in marshes, had short massive limbs, and had one pair of large horns (fused at their bases) growing from its nasal bones, and a second, much smaller pair of horns (behind the large pair) from the frontal bone.

embryo 1 (bot.) Young plant developed from an ovum sexually or asexually and, in seed plants, contained within the seed. 2 (zool.) Young animal that is developing from a sexually fertilized or parthenogenetically activated ovum and that is contained within egg membranes or within the maternal body. The embryonic stage ends at the hatching or birth of the young animal.

embryo sac Female gametophyte (an oval cell in the nucellus of the ovule) of flowering plants, containing several haploid nuclei formed by the division of the haploid megaspore nucleus, and the site of fertilization of the egg and development of the embryo. There are usually eight nuclei within the embryo sac: the egg-apparatus, consisting of an egg nucleus and two synergidae, at the micropylar end; three nuclei at the opposite end, which become separated by cell walls to form antipodal cells and which probably help to nourish the developing embryo; and two polar nuclei in the centre, which fuse to form the primary endosperm nucleus. At fertilization, one male nucleus fuses with the egg nucleus to form a zygote which develops into the embryo. The second male nucleus fuses with the primary endosperm nucleus to form the endosperm nucleus. This then divides to form the endosperm. *See also* double fertilization.

emerald *See* beryl; and corundum.

emergence marsh Upper zone of a salt marsh, from the general mean-high-water level to the mean-high-water level of spring tides. Typically it has fewer than 360 submergences per annum, often with less than one hour of submergence daily during sunlight. The minimum period of continuous exposure may exceed 10 days. *Compare* submergence marsh.

emergents The tallest trees present in an area of tropical rain forest and projecting above the general canopy level. They are designated the 'A layer' in P. W. Richards's (1952) classical five-fold subdivision of the above-ground layers in rainforest vegetation.

Emmelichthyidae (bonnetfish, redbait; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish with a slender body; a large and oblique mouth; toothless jaws; a deeply notched dorsal fin, and a forked tail-fin. Several species, including *Emmelichthys nitidus* (redbait) of S. Australia and *Spicara smaris* (picarel) of the Mediterranean, are of some commercial importance. There are at least 17 species, distributed worldwide in tropical to temperate waters.

Emmelichthys nitidus (redbait) *See* Emmelichthyidae.

empark *See* impark.

emperor *See* Lethrinidae.

emperor angelfish (*Pomecanthus imperator*) *See* Chaetodontidae.

emperor butterflies *See* Nymphalidae.

emperor dragonfly *See Anax imperator*.

emperor moths *See* Saturniidae.

emperors (emperor butterflies) *See* Nymphalidae.

Empetraceae Family of heath-like shrubs in which the leaves are evergreen with inrolled margins; the flowers are very small, borne in clusters, with 4–6 perianth segments in two similar whorls, and two or three stamens; and there are black, juicy drupes for fruits. *Empetrum* (crowberry) is an example.

Empetrum (crowberry) *See* Empetraceae

Empididae (dance flies; class Insecta, order Diptera, suborder Brachycera) Large family of medium to small flies, which have body bristles and a horny proboscis. Cells M and the first M_2 are separate in the wing venation, and cell Cu is usually short. The empodium is linear, and membranaceous or setiform. The group can be distinguished from the Asilidae by the absence of the facial 'beard' and by the much shorter cubital cell in the wing. The proboscis is used to pierce prey and suck it dry, the prey usually consisting of other Diptera. The males often exhibit secondary sexual characters on their legs, as adaptations for holding prey and the female during mating. Mating behaviour also involves 'dancing' up and down by the males, hence the common name. Males often catch items of prey and offer them to females as part of the courtship procedure. Larvae are amphineustic, with pseudopods to aid locomotion. The known larvae are carnivorous on other insects in soil and leaf-litter. There are more than 3000 described species, with a cosmopolitan distribution. *See also* venation.

Empidonax (flycatchers; family Tyrannidae) Genus of small, similar-looking birds, olive-grey above with two wingbars and an eye-ring, buff or yellow below. They are distinguishable by voice. They inhabit woodland and open scrub, catching insects from exposed perches, and building open or semi-pendant nests in trees, rock crevices, or on the ground. There are 17 species, many migratory, found in N., C., and S. America.

empodium Usually, the median bristle or pulvilliform structure that arises between the claws (unques) on the feet of Diptera; but the term is sometimes used to describe the terminal and sometimes claw-like structures on the collembolan tibio-tarsus.

Emsian *See* Devonian.

emu bushes *See Eremophila; Myoporum*; and Myoporaceae.

emus *See* Casuariiformes; Dromaiidae; and *Dromaius*.

emu wrens (*Stipiturus*) *See* Maluridae.

Emydidae (freshwater turtles, terrapins; order Chelonia (Testudines), suborder Cryptodira)

Family of chelonians that bask on land but enter slow-moving water to feed. Usually there is no reduction of the shell. The limbs are flattened with webbed, clawed toes. Emydidae are mainly carnivorous. There are about 80 species, distributed widely in temperate zones, except southern Africa and Australia. *See also Emys obicularis*; and *Terrapene carolina*.

Emys orbicularis (European pond terrapin, European pond tortoise; order Testudines (Chelonia), family Emydidae) Species of carnivorous terrapin, brownish or black, with yellow spots or streaks, which occurs in and around fresh water. The female lays 3–16 eggs. The species is native to central and S. Europe, SW Asia, and NW Africa. It was present in Britain during the last (Ipswichian) interglacial.

enamel Crystals of a calcium phosphate-carbonate salt, containing 2–4% of organic matter, which are formed from the epithelium of the mouth and which provide a hard outer coating to denticles and to the exposed part of teeth.

enation Outgrowth from a leaf in a plant infected with a certain type of virus.

Encalyptales (subclass Bryidae) Order of acrocarpous mosses, in which the leaves are nerved and have a short point at the tip. The capsules are cylindrical and are held erect on long setae; the entire capsule is covered by a distinctive, large calyptra which is often fringed at its lower edge. The order is found chiefly on soils rich in lime, e.g. in crevices in limestone walls, chalk banks, limestone screes, etc. There is one family, one genus (*Encalypta*), and about 35 species, widely distributed.

encephalitis Inflammation of the brain, which may be due for example to virus infection.

Enchytraeidae *See* Prosotheca.

encoppice Enclose a wood or coppice after the underwood has been cut in order to allow regeneration.

encroachment Forest land that has been enclosed illegally to provide a site for a private dwelling.

Encyrtidae (suborder Apocrita, superfamily Chalcidoidea) Family of minute (0.5–7 mm long), usually black or brown, parasitic wasps which have convex mesopleura and mesonota, and middle legs modified for jumping. The adults have a large apical spur on the front tibia, and some are wingless. The larvae are mostly parasitic on scale insects and whiteflies, but some parasitize psyllids, nymphal ticks, potato moths, etc. One group form galls. Many are polyembryonic, producing from 10 to more than 1000 young from a single egg.

endemic *See* endemism.

endemism Situation in which a species or other taxonomic group is restricted to a particular geographic region, due to factors such as isolation or response to soil or climatic conditions. Such a taxon is said to be endemic to that region. The size of the region in this context will usually depend on the status of the taxon: thus a family will be endemic to a much larger area than a species, all other things being equal. Reference is frequently made to 'narrow endemics', i.e. taxa with markedly restricted ranges. Some of these are evolutionary relics, such as the maidenhair tree (*Ginkgo biloba*), a single species within a single genus which is confined to Zhejiang Province, China, where it was discovered in 1758.

endive (*Cichorium endivia endivia*) *See Cichorium*.

end moraine *See* moraine.

endobiotic Growing within a living organism.

endocarp *See* pericarp.

Endoceratida (class Cephalopoda, subclass Nautiloidea) Order of mainly orthoconic cephalopods which contains the longest forms recorded. The siphuncle is large and near-marginal in position. Endocones are prominent, cameral deposits absent. Members of the order are found only in rocks of Ordovician age.

endocrine gland (ductless gland) Gland that produces hormones.

endocuticle *See* exoskeleton.

endoderm In an animal embryo, the layer of cells that gives rise to the lining of the intestine and its associated glands. *See also* gastrulation.

endodermis The innermost layer of the cortex in plants, which plays an important role in controlling the transport of substances within the plant.

endogenetic *See* exogenetic.

endogenous infection Infection with a microorganism that is normally resident in the body.

Endogonaceae (order Mucorales) Family of fungi, in which sporocarps may contain sporangia, chlamydospores, or zygospores. There are three genera, and many species. They are commonly found in mycorrhizal association with higher plants.

endolithic Growing within stone, as do the thalli of certain lichens.

endomitosis Doubling of the chromosomes within a nucleus that does not divide. The doubling may be repeated a number of times in a single nucleus. It occurs mainly in insects, where different adult tissues have specific polyploid numbers; it also occurs in some vertebrate and plant tissues.

Endomycetaceae (order Endomycetales) Family of fungi in which the vegetative stage is mycelial. Single, budding, yeast-like cells do not occur. There are four genera, and several species. They are mainly saprotrophic, and are found on wood, in soil, etc.

Endomycetales (class Hemiascomycetes) Order of fungi in which asci develop directly from zygotes or from single cells. There are four families, most of which are saprotrophic, and found for example on plants and animals.

Endomychidae (class Insecta, order Coleoptera) Family of rounded, convex, hairy beetles, 2–8 mm long, with an expanded pronotum covering most of

the head. Many are brilliantly coloured. The antennae are conspicuously clubbed. Normally the beetles are associated with fungi on forest trees. Larvae are oval, with sides concealed by expanded tergites. Temperate species are found in decaying vegetation, dung, and stored products. There are 1100 species, mostly tropical.

endomycorrhiza Type of mycorrhiza in which the hyphae of the fungus actually penetrate the cells of the root. Endomycorrhizas are found in a wide range of plant types.

endoparasite *See* parasitism.

endopeptidase *See* protease.

endoperidium The inner layer of a double-layered peridium in certain fungi of the Gasteromycetes.

endophallus The inner wall of the aedeagus of an insect, derived embryologically by the fusion of paired genital papillae to form a medial tube. The endophallus is flexible and eversible, and is the true intromittent organ.

endophloeodal Growing within bark.

endoplasm In plant cells and some Protozoa, the inner layer of cytoplasm within which are embedded the principal cell organelles.

endoplasmic reticulum Complex network of cytoplasmic membranaceous sacs and tubules which appears to be continuous with both the nuclear and plasma membranes. It occurs in two forms: that bearing ribosomes is termed rough ER; that without, smooth ER. Both are involved in the synthesis, transport, and storage of cell products.

endopod In Crustacea, the inner ramus of the biramous limb.

endopterygote Insect in which the wings develop internally until the final moult, when they undergo a pupal stage and complete metamorphosis.

endoskeleton Skeleton that is contained within the body; the vertebrate skeleton.

endosperm 1 Structure found in many seeds of Angiospermae: it frequently stores food materials which are broken down during germination. 2 *See* embryo sac; and double fertilization.

Endospermum (family Euphorbiaceae) Genus of soft-wooded, fast-growing trees in which the leaves are large, often peltate, with stellate hairs. The fruits are globose, indehiscent, and leathery. The trees produce a light, general-utility timber. There are 10 species, occurring from China and SE Asia to Fiji.

endospore (bacterial) Type of resting cell that develops within a vegetative cell under certain conditions. Endospores are extremely resistant to adverse environmental conditions.

endostracum Layer of generally nacreous calcium carbonate which is present on the internal surface of the shells of certain pelecypods and other molluscs.

endostyle Ciliated groove on the midventral surface of the pharynx of larval lampreys (family Petromyzonidae) or ammocoetes. Food particles are first trapped by mucus produced by the pharynx, and then transported toward the gullet or oesophagus. In addition, the endostyle is able to take up iodine, a capacity it retains after it is transformed into the thyroid gland of the adult lamprey, when metamorphosis is complete. A very similar endostyle is present in the invertebrate classes Ascidiacea and Cephalochordata.

endotherm *See* homoiotherm.

endotoxin Component (lipopolysaccharide) of the walls of Gram-negative bacteria: it is toxic to animals, including humans.

energy budget *See* radiation budget.

energy flow The exchange and dissipation of energy along the food-chains and food-webs of an ecosystem.

energy of activation *See* activation energy.

Engelhardtia (family Juglandaceae) Genus of trees, in which the leaves are pinnate, and the flowers tiny and borne in panicles. The fruit is a small, hard nut attached to an enlarged, wing-like bract. The trees yield useful timber. There are eight species, three occurring in the neotropics, and five from the W. Himalayas to New Guinea.

englacial Contained within the interior of a glacier, as opposed to being at its base (subglacial) or on its surface (supraglacial). Normally the term is applied to meltwater or drift.

engram Memory trace stored in the brain.

Engraulidae (anchovy; class Osteichthyes, subclass Actinopterygii, order Clupeiformes) Family of small, silvery, marine fish related to the herrings, which can be identified by the long snout projecting over the lower jaw, and by the single, soft-rayed, dorsal fin. They are slender-bodied fish with a large mouth, travelling in huge schools near the shore. Many species, including *Engraulis encrasicolus* (European anchovy) are of considerable importance as food fish or as bait fish, the annual catch in Europe amounting to some 300 000 tonnes. There are about 110 species, distributed worldwide.

Engraulis encrasicolus (anchovy) *See* Engraulidae.

Enneapogon (nine-awn grasses; family Gramineae) Genus of slender, tufted, often glandular-hairy grasses which are perennial, annual, or erratic; and brought into flowering by rainfall. The leaves are narrow and small. The panicle is compact, with the spikelets grouped closely together. The lemma of each floret has a fringe of nine short and fluffy awns. The flower head is dark in colour. There are about 30 species, found in warm-temperate regions of the Old World and Australia, in which there are nine endemic species. The grasses are found in dry habitats on grassy plains and hills. Some species are highly-valued pasture grasses, e.g. *E. cylindricus* (jointed nine-awn), found in the calcareous grasslands of Australia.

Enneapogon cylindricus (jointed nine-awn) *See Enneapogon*.

Enopla (phylum Nemertini) Subclass of nemertinid worms in which the proboscis is either complex or absent. The mouth is either in front of or below the brain.

Enoplosidae (old wife; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish including only one species, *Enoplosus armatus* (old wife). It is an attractive, deep-bodied fish with a small mouth, long, spinous and soft-rayed dorsal fins, and large pelvic fins. It is found in coastal regions of E. Indonesia and E. Australia.

Enoplosus armatus (old wife) *See* Enoplosidae.

enrichment In forestry, the planting of young trees among a woodland crop.

Ensete (family Musaceae) Genus of giant, banana-like herbs, whose inflorescences are terminal, with big persistent bracts. There are six or seven species, occurring in Africa and Asia.

Ensifera (class Insecta, order Orthoptera) Suborder that includes the families Cooloolidae, Gryllacrididae, Gryllidae, Gryllotalpidae, Myrmecophilidae, Prophalanopsidae, Rhaphidophoridae, Schizodactyllidae, Stenolpelmatidae, and Tettigoniidae. The antennae have more than 30 segments, usually many more, and in some groups are several times the length of the body. When present, auditory organs are found on the fore-tibia, and stridulation is produced by friction between modified veins on the forewings. When present, the modified ovipositor is cylindrical or sword-shaped (ensiform —hence 'Ensifera').

ensiform Sword-shaped. *See* Ensifera.

ensign flies *See* Sepsidae.

ensign wasps *See* Evaniidae.

ensilage *See* silage.

enstatite Mineral, specific gravity 3.1–3.3, hardness 5.5, chemical composition $Mg_2(Si_2O_6)$, whose name is derived from the Greek word for 'resistant'. It occurs in magnesium-rich, magmatic rocks (e.g. peridotites, gabbro-norites and basalts, and andesites), and in contact-metasomatic zones associated with these rocks. It can be colourless or greyish-white, with a green tinge, and it can also be brownish-green, all with a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are prismatic or tabular, but they normally form very irregular grains. It is a rock-forming mineral.

Entada (family Leguminosae, subfamily Mimosoideae) Genus of shrubs and big, woody climbers, several of which have gigantic flat pods, up to 2 m long. The seeds are big and flat, and are often carried by sea currents. Cut stems of many climbers yield potable water. There are 40 species, with pantropical distribution.

Entamoeba (order Amoebida) Genus of cyst-forming, parasitic amoebae. Most species do not cause disease, but *E. histolytica* can cause amoebic dysentery in humans.

Entandophragma (family Meliaceae) Genus of big, deciduous trees in which the leaves are pinnate, the fruit a capsule, and the seeds winged. They are important for timber, notably sapele and utile. There are 11 species, occurring in tropical Africa.

entelechy *See* aristogenesis.

entellus langur (*Presbytis entellus*) *See* Cercopithecidae.

Entelodontidae So-called giant pigs, which diverged from palaeodont stock in the Eocene. They flourished in the Oligocene, but disappeared in the Miocene, probably as a result of displacement by the true pigs and peccaries. Although they grew to the size of bison, to judge from their long limbs they were fast runners.

Enterobacteriaceae Large family of bacteria, which are Gram-negative and rod-shaped. They are chemo-organotrophic and can grow in the presence or absence of air. There are many genera, found as parasites and pathogens in a wide range of organisms from plants to humans. Many can also live saprotrophically, e.g. in soil and water.

Enteromorpha (family Ulvaceae, order Ulotrichales) Genus of green algae in which the thallus consists of elongated, hollow, tubular fronds with walls only one cell thick. The fronds may be simple or branched. The species are often difficult to distinguish from one another. *E. intestinalis* is a common species in Britain, occurring in rock pools on the upper shore and in estuaries; the thallus is typically irregularly inflated, giving the resemblance to an intestine, and may reach up to 1.5 m in length and 1.5–2.0 cm in diameter.

enteron Body cavity in Coelenterata.

Enteropneusta (subphylum Stomochorda) Class of free-living, elongate, worm-like, burrowing marine animals in which the body is clearly divided into a proboscis (protosoma), collar (mesosoma), and trunk (metasoma). The stomochord extends into the proboscis. The branchial apparatus is well developed, consisting of a long, double row of pores strengthened by a cuticular skeleton. There are many living genera. No fossil examples are known.

enterotoxin Type of toxin, produced by certain bacteria, which affects the function of the intestinal mucosa, causing diarrhoea, gastroenteritis, etc.

enteroviruses Group (genus) of viruses in the Picornaviridae which includes many important viruses, including those responsible for poliomyelitis. They are found in the intestinal tract of animals.

Entisols Embryonic mineral soils, an order of the USDA Soil Taxonomy that have no distinct pedogenic horizons. Representing only the initiation of soil-profile development, Entisols are common on recent floodplains, steep eroding slopes, stabilized sand-dunes, and recent deep ash or wind deposits.

Entodiniomorphida (subclass Spirotrichia) Order of ciliate protozoa, which occur as commensals in the rumen of cattle, sheep, and other ruminants,

and in the gut of various other herbivores (e.g. horses). The organisms are anaerobic and can digest cellulose. There are two families, and many genera.

Entognatha In some classifications, a superorder of insects comprising the entognathous groups Collembola, Protura, and Diplura.

entognathous Eversible and contained within a small pocket.

Entoloma (family Entolomataceae, order Agaricales) Genus of fungi in which the fruit body is mushroom-like with confluent stipe and cap. The spore deposit is pink or brownish; under the microscope the spores appear angular. *Entoloma* is found on the ground, often under trees.

entomopathogenic Capable of causing disease in insects.

entomophilous Applied to flowering plants with floral parts that are adapted to pollination by insects.

Entomophthorales (class Zygomycetes) Order of fungi in which the sporangium functions as a single conidium and is discharged forcibly at maturity. Most are mycelial and coenocytic. There is one family, with six genera. Many species are parasitic in insects or other animals; some can parasitize desmids or fern prothalli, while others are saprotrophic.

entomopoxviruses (Entomopoxvirinae) A group (subfamily) of viruses in the poxvirus group (Poxviridae), which infect insects of a wide range of types, causing diseases known as spheroidoses.

Entoprocta (phylum Bryozoa) Subphylum of freshwater bryozoans which entirely lack a mineralized skeleton. The lophophore surrounds both the anus and the mouth. Many fossil forms are known, but the subphylum is known only from the Cenozoic. Formerly the Entoprocta was classified as a separate animal phylum, although its many resemblances to the Bryozoa were recognized.

entrainment Process by which air from the environment outside a growing cloud is caught into the rising convective current within the cloud and mixed with the cloudy air. This is significant in that it reduces the buoyancy of the rising current and causes cloud growth by reason of the cooler, drier air which is introduced. This also causes some evaporation of cloud droplets. When very dry air is introduced, entrainment can produce rapid dissipation of the cloud.

entropy Measure of disorder or unavailable energy in a thermodynamic system; the measure of increasing disorganization of the universe.

enveloped virus Virus in which the virion is surrounded by a membrane-like envelope composed of lipid and protein. The envelope is usually derived from the membranes of the host cell.

environment The complete range of external conditions, physical and biological, in which an organism lives. Environment includes social, cultural, and (for humans) economic and political considerations, as well as the more usually understood features such as soil, climate, and food supply.

environmental biology Study of the environment in which organisms live and its influences upon them. The term is almost synonymous with 'ecology'.

environmental hormone *See* ectocrine.

environmental-impact assessment (environmental-impact statement, EIA) An attempt to identify and to predict the impact on the biogeophysical environment and on human health and well-being of proposed industrial developments, projects, or legislation. EIA also aims to devise easily comprehended, universally applicable schemes for communicating the results of the assessment.

environmental lapse rate (ELR) The rate at which the air temperature changes with height in the atmosphere surrounding a cloud or a rising parcel of air. The overall average rate is a decrease of about 6.5 °C/km, but the rate varies greatly in different regions of the world, in different airstreams, and at different seasons of the year. Where the lapse rate of temperature is negative (temperature increases with height), an inversion is said to exist.

environmental resistance The sum total of the environmental limiting factors, both biotic and abiotic, that together act to prevent the biotic potential of an organism from being realized. *See also* logistic equation.

environmental science The study of environments. This may be interpreted fairly strictly as the physical environment; or may include the biological environment of an organism; or, in its widest sense, may also consider social, cultural, and other aspects of the environment.

environmental studies General term applied to courses in environmental science taught in educational institutions. The definition of environmental science is imprecise, and the exact content of environmental studies courses may vary widely.

environmental variance The portion of phenotypic variance that is due to differences in the environments to which the individuals in a population have been exposed. The total amount of variance observed amongst individuals in a population will be made up by an environmental component, determined by environmental variation, and a genetic component, determined by the variation that is inherited.

enzootic Applied to a disease of animals that is restricted to a given geographical locality.

enzyme Molecule, wholly or largely protein, produced by a living cell, that acts as a biological catalyst. Enzymes are present in all living organisms, and through their high degree of specificity exert close control over cellular metabolism.

Eoagnostus roddyi Early representative of the trilobite order Agnostidae. It is in fact the first recorded species of the family Quadragnostidae (Peronopsidae), described by Howell 1935. It is a

small trilobite with few thoracic segments, and is recorded from the Lower Cambrian of Pennsylvania, N. America.

Eobactrites sandbergeri Recorded from the Lower Ordovician of Czechoslovakia, this species is thought by some workers to be the earliest representative of the cephalopod molluscs, the Ammonoidea. *Eobactrites* was a straight-shelled form with no internal deposits related to buoyancy control.

Eocambrian Little-used term employed in the description of sequences of unfossiliferous rocks that were deposited at the end of the Precambrian.

Eocene Tertiary epoch which began at the end of the Palaeocene approximately 54 million years ago, and ended at the beginning of the Oligocene 17.5 million years later. It is noted for the expansion of mammalian stocks (horses, bats, and whales appeared during this epoch), and the local abundance of nummulites (marine protozoans of the Foraminiferida).

Eocrinoidea (subphylum Pelmatozoa) Extinct class of cystoid-like echinoderms which range in age from Lower Cambrian to Middle Silurian (Lower Palaeozoic). Globular or flattened theca composed of numerous, irregularly arranged plates lack thecal pores typical of cystoids, and their sutural pores are unlike those of cystoids. Food grooves are extended on an exothecal skeleton of erect, unbranched, biserial processes (brachioles), which are not homologous with the arms of crinoids. Although six orders have been recognized, only one, the Imbricata, has been named.

Eodelphis Known from the Upper Cretaceous of N. America, *Eodelphis* is a genus of early opossums, marsupials with long prehensile tails. Opossums are arboreal in habit and are thought to represent the ideal stem stock from which evolved the whole marsupial group. Several species of *Eodelphis* are known from the Milk River Formation (Upper Cretaceous) of Alberta. The teeth of *Eodelphis* are sharply cusped and somewhat primitive in form.

Eognathosomata (class Echinoidea) Name given to a group of irregular echinoids comprising the order Pygasteroida, and the suborders Holectypina and Echinoneina of the order Holectypoida.

'Eohippus' *See Hyracotherium*.

eolian *See* aeolian.

Eosphaera tyleri Ancient, single-celled organism from the Gunflint Chert of Canada, which probably possessed a well-organized, membrane-bound nucleus and is therefore considered to be one of the first eukaryotes. The Gunflint Cherts were deposited around 2000 million years ago.

Eozostrodon One of the earliest recorded mammals, known from the Triassic of Europe and probably China. It was a small animal resembling a tree shrew.

Epacridaceae Family of shrubs and small trees, which are heath-like and the southern counterpart of the Ericaceae. The flowers have free sepals; the stamens are epipetalous; the anther opens by slits. The fruit is a drupe. There are 21 genera, with 400 species, occurring mainly in Australasia, but a few extending to Indo-China, and also occurring in southernmost America.

Epacris (family Epacridaceae, tribe Epacrideae) Genus mostly of shrubs, similar to *Erica* and *Calluna* species in the northern hemisphere. They have narrow, simple, sessile, and alternate leaves. The flowers are small and borne in spikes or racemes. There are several ovules to each locule, and the fruit is a capsule. Several species are grown as ornamental winter-flowering shrubs. There are 40 species, endemic to SE Australia, Tasmania, and New Zealand.

Epallaginidae (Euphaeidae, damselflies; class Insecta, order Odonata, suborder Zygoptera) Family of damselflies, which are often metallic-coloured, or iridescent. The nymphs are thick-set, with a short abdomen. They occur in the Old World tropics, and 47 extant species have been described.

epeiric sea Shallow sea which extends far into the interior of a continent, e.g. Hudson Bay and the Baltic Sea. The term also denotes shallow sea areas that cover the continental shelf and are partially enclosed, e.g. the North Sea.

epeirogenic Applied to large-scale upward or downward movements of continental or oceanic areas. Epeirogenic movements should not be confused with the more dynamic mountain-building episodes of an orogeny.

Epeolus *See* Anthophoridae.

Eperua (family Leguminosae, subfamily Caesalpinioideae) Genus of trees in which the leaves are pinnate. *E. falcata* (wallaba) yields a hard, valuable timber, and grows gregariously on white-sand soils. There are six species, occurring in tropical S. America.

Ephedra (family Ephedraceae) Genus of shrubs, which have scale-like leaves and whip-like, slender green stems. They are gymnosperms, related to *Gnetum*; and their ovule is naked within the perianth which becomes woody around the seed. There are 400 species, found in the warm-temperate regions of each hemisphere.

ephemeral (ephemerophyte) Plant that completes its life cycle very rapidly. In favourable environments ephemerals may germinate, bloom, and set seed several times during a single year. Many weed species are ephemerals. Ephemerals are also particularly characteristic of desert environments.

Ephemerellidae (mayflies; subclass Pterygota, order Ephemeroptera) Family of insects whose nymphs are strikingly and cryptically coloured, and favour rapid, cool, clear streams or small lakes. The family has an almost worldwide distribution.

Ephemeridae (mayflies; subclass Pterygota, order Ephemeroptera) Family of insects whose nymphs occur in ponds, lakes, and large rivers, and have a burrowing habit. The head has a frontal process and long, tusk-like mandibles for loosening the silt, which is pushed sideways by the front legs and out

of the burrow by the hind legs. The feathery gills are in continuous motion during digging, and the nymph feeds on detritus excavated from the burrow. The family contains some of the largest mayflies. Many have clear wings, although a few have spotted wings. Members of a particular species often emerge in large numbers.

ephemerophyte *See* ephemeral.

Ephemeroptera (mayflies; subclass Pterygota, infraclass Palaeoptera) Order of insects in which the adults are short-lived, surviving from a few hours to a few days (the name is derived from the Greek *ephemeros*, lasting only a day). The order is somewhat primitive, its members having two pairs of membranaceous wings with a simple network of veins, resembling the venation of dragonflies. The eyes are large; the antennae are short; the mouthparts are unsclerotized and vestigial (the adults do not feed); the thorax is strongly developed for flight; and the abdomen possesses three long tail filaments. The adults are small to medium-sized, soft-bodied insects, with large, triangular forewings, and small, rounded, hind wings. The wings are held rigidly upright above the body at rest. The nymphs are aquatic and herbivorous, although some have sharp, modified mandibles and are partly predacious. The nymphal stage may last several years, but the majority are univoltine (i.e. have one generation each year that reaches maturity). The metamorphosis is simple and there is no pupal stage, the first winged stage being known as the subimago, or dun. The subimago resembles the adult, but is often a dull-brown colour. The subimaginal stage may last as little as five minutes before the skin is shed and the brightly coloured adult (spinner) emerges. The males fly in swarms with a dancing, vertical flight, and have several mating adaptations (e.g. reversible foreleg tarsal joints) and modified eyes. Ephemeroptera are unique in that they undergo a moult after wings have become full-sized and functional. The 2100 species are an important part of the diet of freshwater fish, and many, with leaf-like, abdominal gills, are used as models for angling lures.

Ephippidae (spadefish, batfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, in which the compressed, flattened body is usually nearly as deep as it is long. The small mouth, steep forehead, and the large second dorsal and anal fins are also typical. Fairly slow-moving fish, they are found near rocky outcrops or coral reefs. *Platax pinnatus* (pinnate batfish) of tropical Australia grows to 50 cm, but the young are popular and colourful aquarium fish. There are about 15 species, occurring worldwide in warm to temperate waters.

Ephthianuridae (Australian chats; order Passeriformes) Family of small, brightly coloured, short-tailed birds with fairly short, slightly decurved bills. They inhabit marshy ground and dry plains, and are mainly terrestrial, running along the ground to catch insects. They build an open nest in bushes near the ground. There are two genera, with five species, found in Australia. This family is sometimes placed with the Maluridae.

epibiotic Growing on the surface of a living organism.

epicalyx Whorl of sepal-like appendages which resembles the calyx but is outside the true calyx.

epicardial tube In Urochordata, a perivisceral space formed by the outgrowth of the pharynx.

Epicharis *See* Anthophoridae.

Epichloë (family Clavicipitaceae) Genus of fungi which are parasitic on grasses. *E. typhina* is responsible for the condition known as 'choke'. It forms a ring of conidia-bearing mycelium around the uppermost leaf sheath. The mycelium turns orange as perithecia develop.

epicuticle *See* exoskeleton.

epidemic Outbreak of disease in which many individuals in a population are affected.

epidemiology The study of the relationships in disease development between pathogenic organisms, their hosts, and the environment.

epidermis The outermost layer or layers of cells in a plant or animal. It is one cell thick in plants and in many invertebrates, but many cells thick in vertebrates. In land-dwelling vertebrates it is formed from dead, hardened (keratinized) cells.

epidote Mineral, with a specific gravity of 3.3–3.4, hardness of 6.5, and with the chemical composition $Ca_2(AlFe)_3(Si_2O_7)(SiO_4)O(OH)$, whose name is derived from the Greek word for 'increment'. It occurs in hydrothermal formations, especially associated with altered, basic, igneous rocks, and in contact metamorphic zones with chlorite, quartz, calcite, and sulphides. It can also replace a variety of minerals. Its diagnostic feature is its colour, which is normally pistachio-green, but can also be various shades of green, yellow, grey, or black; and it has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are prismatic parallelograms, often rod-like and isometric, which often show radial, fibrous, and columnar masses. It is a rock-forming mineral.

epifauna Benthic organisms that live on the surface of the sea-bed, either attached to objects on the bottom or free-moving. They are characteristic of the intertidal zone. *Compare* infauna.

epigamic Character of an animal that serves to attract or stimulate members of the opposite sex during courtship. Examples are the distinctive coloration of some male birds and fish, the colourful crest of the male crested newt, and the song of birds. Such characters may also have other functions such as discouraging potential competitors for mates or food resources.

epigeal *See* germination.

epigean (epigeal) Growing or occurring above ground.

epigene Produced or occurring at the Earth's surface. The term is used especially in relation to the processes of weathering, erosion, and deposition. 'Epigenetic drainage' is sometimes used as a synonym for 'superimposed drainage'.

epigenesis The hypothesis that an organism develops by the new appearance of structures and functions. An alternative hypothesis (termed 'preformation') is that development of an organism occurs by the unfolding and growth of characters already present in the egg at the beginning of development.

epigenetic drainage Superimposed drainage. *See also* drainage; and epigene.

epigenetics The study of the mechanisms by which genes bring about their phenotypic effects. *See* phenotype.

epiglottis In mammals, a flap of cartilage and mucous membrane on the ventral wall of the larynx, at the base of the tongue. During swallowing the entrance to the trachea is pushed against it and so closed.

epigyne *See* Araneae.

epigynous Applied to a flower in which the calyx, corolla, and stamens are inserted near the tip of the ovary.

Epilachna varivestis (Mexican bean beetle) *See* Coccinellidae.

epilimnion The upper, warm, circulating water in a thermally stratified lake in summer. Usually it forms a layer that is thin compared to the hypolimnion.

epilithic Growing on or attached to the surfaces of rocks or stones.

Epilobium (family Onagraceae) Genus of herbs, usually of open habitats, in which the leaves are simple and opposite, or alternate. The flowers are generally solitary but some are in racemes. Numerous seeds, without endosperm, are produced from the capsule with a plume of hairs at the chalaza (ovule base). There are 215 species, of northern and southern temperate and arctic regions.

epimorphic 1 In hexapods, applied to post-embryonic development in which little change occurs beyond the addition of antennal segments and the development of the chaetotaxy towards the mature condition. 2 *See* epimorphosis.

epimorphosis (epimorphic growth) Condition in some Chilopoda (centipedes) in which the young possess the full complement of adult body segments on hatching. *Compare* anamorphosis.

epinastic growth Differential growth of the upper or adaxial part of a plant organ. A well-known example is the growth of the upper side of the petiole causing the leaf to be bent downwards. Auxin and ethene are involved in this response, which may also be induced by application of herbicides.

epinasty Symptom of disease in plants in which there is a pronounced and atypical bending downwards of the leaves.

epinephrine *See* adrenalin.

epineustic *See* zooneuston.

Epiophlebiidae (dragonflies; class Insecta, order Odonata, suborder Anisozygoptera) The only family in its suborder, comprising two known species, found in India and Japan. Their wings have many antenodals, the first one being thickened. The second branch of the median vein arises at the subnodus. *See also* venation.

epipelic Growing on mud.

epipetalous Borne on the petals, by concrescence. *See also* concrescent.

epiphloeodal Growing on or attached to the surface of tree bark.

epiphysis 1 Pineal body. 2 In the limbs and vertebrae of mammals, a cap of bone at joints: during growth it is separated from the main bone by a cartilaginous plate; it then ossifies separately, the whole fusing when growth ceases. The extent of the fusion can sometimes be used to estimate the age of an animal.

epiphyte Herbaceous plant that uses another plant, typically a tree, for its physical support, but which does not draw nourishment from it. Well-known examples include *Platycerium* (staghorn fern) and most members of the Orchidaceae. Epiphytes are a conspicuous feature of tropical rain forests.

epiphytotic Outbreak of disease (an epidemic) in a population of plants.

epipodite In some Crustacea, an accessory appendage on the basal segment of the limb.

Epipolasida (class Demospongiae, subclass Tetractinomorpha) Order of sponges whose body has a radial structure. Organic fibres and spicules form the skeleton. The cortex is well developed. Most spicules have four axes. The group first appeared in the Cambrian.

epipubic bone In male and female Marsupialia and Monotremata, a rod-like bone which projects forward from the pelvis. In females it helps support the marsupium.

episepalous Borne on the sepals, by concrescence. *See also* concrescent.

episodic evolution The fossil record is characterized by extinction events and succeeding phases of rapid evolutionary innovation. The overall picture is thus one of episodic evolution. However, the term has recently acquired other connotations, and tends to be linked with punctuated equilibrium.

epispire *See* Imbricata.

epistasis Situation in which an allele of one gene (called the epistatic gene) prevents the expression of all allelic alternatives of another gene. For example, the recessive gene apterus (ap) in *Drosophila* produces wingless homozygotes: in such individuals any other recessive gene affecting wing morphology will have its expression masked. The apterus gene is then epistatic to genes like curly wing; conversely these are hypostatic to it.

epistome 1 In Bryozoa and Endoprocta, a lobe or ridge which overhangs the mouth. 2 In some Crustacea, a ventral plate which lies in front of the mouth.

epithecium Layer of tissue that covers the hymenium in an ascocarp.

epithelium Animal tissue type which consists of a sheet or tube of tightly packed cells with the minimum of intercellular material. Epithelia cover the exposed surfaces of the body, often line tubes and cavities, and are frequently secretory in function.

epixylous Growing on wood.

epizoic Applied to non-parasitic animals that attach themselves to the outer surface of other animals.

epizootic Outbreak of disease (an epidemic) in a population of (non-human) animals.

epoch One of the intervals of geological time recommended by the International Subcommission on Stratigraphic Terminology. An epoch is ranked as a third-order time unit, and is the equivalent of the chronostratigraphic unit 'series'. Several epochs form a period; several periods an era. When used formally, the initial letter is capitalized, e.g. Early Devonian Epoch.

epsomite (Epsom salts) Mineral, specific gravity 1.7, hardness 2.5, and with the chemical composition $MgSO_4.7H_2O$, named after mineral springs at Epsom, England. It occurs as encrusting masses in caves and old mine workings, and also in the oxidized zones of pyrite deposits in arid regions. It is distinguished by its fibrous habit which is readily soluble in water and has a bitter taste. It is colourless to white, and has a vitreous to earthy lustre. It crystallizes in the orthorhombic system. Crystals are rare except locally, but they show a fibrous structure.

Epsom salts *See* epsomite.

Epstein–Barr virus Enveloped, DNA-containing virus of the herpesvirus group. It is the causal agent of glandular fever (infectious mononucleosis); some types are associated with tumour formation.

equatorial current Oceanic current which flows in an east–west direction in equatorial regions of all the oceans. The broad (1000–5000 km) westward flowing currents (north and south equatorial currents) are separated by a comparatively narrow eastward-flowing countercurrent (the equatorial countercurrent). The flow tends to be limited to the upper 500 m of the water column and the velocity is 25–100 cm/s. The strength and position of the equatorial currents are controlled by the overlying wind system.

equatorial division The division of each chromosome during the metaphase of mitosis or meiosis into two equal longitudinal halves which are then incorporated into separate daughter nuclei.

equatorial plate An arrangement of the chromosomes in which they lie approximately in one plane, at the equator of the spindle. This is seen during metaphase of mitosis and meiosis.

equatorial trough Shallow low-pressure zone around the equator, where the trade-wind systems tend to converge. *See also* intertropical convergence zone; and doldrums.

Equidae (horses; order Perissodactyla, suborder Hippomorpha) Family that includes the modern horses, asses, and zebras (all of which are placed in a single genus *Equus*, which is divided into six or seven—depending on the system used—species), and many extinct forms, the earliest being known from the late Palaeocene. Sufficient of these are believed to be ancestral to modern equids for the evolution of the family to have been traced in considerable detail. The domestic horse (*E. caballus*) is probably not descended from the only true living wild horse, Przewalski's horse (*E. ferus przewalskii*), but from a progenitor closely related to it. Modern equids are adapted for rapid movement: they have a short humerus and femur, and a long radius and tibia; the ulna is reduced and fused to the radius, and the fibula is also reduced. Only the third toe is developed. All the incisors are present; canines are present in males; and the cheek teeth are hypsodont, with complex grinding surfaces. The brain is large and senses of sight, smell, touch, and hearing are highly developed. Equids are migratory grassland animals, graze mainly on grasses, and have complex social organization. Wild species are found in Africa and parts of central and western Asia. The horses are first represented in the fossil record by *Hyracotherium*, which diverged from a condylarth predecessor in the Palaeocene. Numerous evolutionary lines subsequently appeared from this fox-sized prototype. Most of the evolutionary advances occurred in the New World, although the Equidae were to survive the Pleistocene only in the Old World. The conquistadores reintroduced horses to the Americas in the sixteenth century.

equids *See* Equidae

equilibrium (geomorph.) Steady state of balance between the processes acting on a landscape and the resisting earth materials so that over time the form is little changed. Individual land-forms, such as river profiles and hillslopes, may show similar balance. As it is recognized that a perfect balance cannot exist, the terms 'quasi-' and 'dynamic' equilibrium are sometimes used.

equilibrium line Line on a glacier that divides the zone of ablation from the zone of accumulation.

equilibrium species Species in which competitive ability, rather than dispersal ability or reproductive rate, is the chief survival strategy: competition is the typical response to stable environmental resources. In unstable or extreme environments, e.g. deserts, equilibrium species survive unfavourable periods by living on stored food resources and reducing life processes to a minimum. *Compare* fugitive species.

equinoctial gale Term derived from the popular misconception that gales are more frequent at periods close to the equinoxes.

Equisetum (class Sphenopsida, family Equisetaceae) Sole surviving genus of its class and family, comprising the horsetails, which typically are plants of damp places. They are vascular cryptogams with hollow stems, tiny, scale-like leaves, branches in whorls, and apical, spore-producing cones. The

spores germinate into prothalli bearing the sex organs. The sperms are multiciliate. There are about 23 species, almost cosmopolitan in distribution except for Australasia. In Carboniferous times the Sphenopsida produced tree-like forms. One such is *Calamites*, a common coal-measure fossil, which grew to heights of 30 m, and, apart from its size and woody stems, closely resembled *Equisetum*.

Equisitites hemingwayi The first known species of the family Equisetaceae, known from the Carboniferous of Europe, and the direct ancestor of the only extant genus *Equisetum*.

equivalence point *See* minimal area.

Equus (horse) *See* Equidae.

era First-order geological time unit composed of several periods. The Mesozoic Era, for example, is composed of the Triassic, Jurassic, and Cretaceous Periods, dating from 225 million years ago to 65 million years ago. When used formally the initial letter is capitalized.

Eremophila (emu bush; family Myoporaceae) Genus of shrubs and trees of arid zones, mainly found inland. They have alternate, entire leaves, often sticky or shiny. The flowers are large, colourful (red or white), tubular, two-lipped corollas, with the calyx united in a bell-like tube which remains on the fruit. The fruit is a fleshy or dry drupe with a hard inside shell containing several seeds. *Eremophila* are good horticultural plants in hot, dry areas, and *E. mitchelli* provides useful timber. There are 105 species, endemic to Australia.

Eremophila alpestris (shore lark, horned lark) *See* Alaudidae.

Erethizontidae (New World porcupines; order Rodentia, suborder Hystricomorpha) Family of arboreal rodents in which some hairs are modified to form barbed spines. The body is thickset, the legs are short, and long claws are borne on each of the four digits of all limbs. First digits are reduced. In the tree porcupines (*Coendou*) the tail is prehensile. Porcupines are distributed widely throughout N. America and tropical S. America.

Eretmochelys imbricata (hawksbill turtle; order Chelonia (Testudines), suborder Cryptodira, family Cheloniidae) The smallest species of marine turtle (length up to 90 cm), which is found in shallow tropical seas. The horny plates of the carapace are multi-coloured and translucent, and overlap towards the back. They are used in the oriental tortoiseshell industry. The turtles are omnivorous, feeding mainly on crustaceans, molluscs, and algae.

erg Sand sea in a hot desert. It is a feature of the Sahara, where sand typically is accumulated in wide shallow basins as alluvial and lacustrine deposits derived from adjacent rocky desert during the Cenozoic. It is often very large: the Grand Erg Oriental covers 196 000 km^2 in Algeria and Tunisia.

ergatogyne Form intermediate between worker and queen which occurs in some ant species. The gaster is larger than that of a worker, but the head and thorax are worker-like. It can function as an additional reproductive, or replace the queen.

ergot Disease which affects many grasses, including cereals. It is caused by the fungus *Claviceps purpurea*; the hard, black sclerotia of the fungus replace the grain in the spikelets of an infected plant. These sclerotia contain alkaloids which can cause severe poisoning or even death if ingested by animals or humans.

ergotism Poisoning due to the ingestion of ergot alkaloids, either in humans (e.g. following ingestion of bread made from grain infected with ergot) or in other animals (following ingestion of ergotized hay or grain feed). The alkaloids may be lethal if ingested in sufficient quantity. In small doses some ergot alkaloids have uses in medicine, e.g. to prevent haemorrhage after childbirth, and in the treatment of migraine.

Erica (heaths; family Ericaceae) Genus of shrubs and a few trees, in which the leaves are leathery and small. The flowers are bell-like, with a disc. *E. scoparia* of S. Europe is bruyère, whose roots provide briar pipes. There are 500 species, occurring from Europe to Asia Minor and the African mountains, and species are very numerous in S. Africa.

Ericaceae Family of shrubs and small trees, in which the leaves are leathery and evergreen. The flowers have four or five free sepals, a corolla of four or five fused petals, and 8–10 free stamens. The anthers are porous, and the ovary may be superior or inferior. The fruit is a capsule, drupe, or berry. There are 50 genera, with 1350 species (although some authors count up to 100 genera, and 3000 species): they are cosmopolitan in distribution but centred in the northern hemisphere and almost absent from Australasia.

ericelo *See* Mediterranean scrub.

Erigeron (family Compositae) Genus of mainly perennial herbs with simple leaves which are either in a radical rosette or alternate. The flower heads are stalked, solitary, or in panicles. The herbaceous involucre bracts are numerous, and either all of one length or in two or more rows; the ray-florets are female and numerous, in two or more rows. The disc-florets are bisexual, tubular, and five-toothed. The achenes are flattened with a pappus of bristles. There are about 200 species, found throughout the temperate regions of the world, but especially in America. Some species are alpine. Many are now naturalized in regions to which they have been introduced.

Erigonum *See* Polygonaceae.

Erilepis zonifer (skilfish) *See* Anoplopomatidae.

Erinaceidae *See* Erinaceoidea.

Erinaceoidea (hedgehogs, moon rats; order Insectivora, suborder Lipotyphla) Superfamily, embracing several extinct families, e.g. the Adapiscoricidae and the Dimylidae, and the extant family Erinaceidae, with its two subfamilies, Erinaceinae (hedgehogs) and Echinosoricinae (moon rats).

Erinaceoidea are insectivores, in the more advanced of which (hedgehogs) the hairs of the back are modified to form spines. The senses of sight and hearing are more acute than in many insectivores. The limbs have five digits (except in the genus *Atelerix* which has four on the hind limbs). Hedgehogs have some immunity to toxins, including snake bite, and chew toxic substances to make a froth with which they annoint their spines. Nocturnal animals feeding on small invertebrates, they are distributed throughout the Old World. In the Oligocene and Miocene hedgehogs and moon rats were equally common in Europe; today the moon rats (e.g. *Echinosorex gymnurus*, the gymnure or Malayan moon rat) are confined to SE Asia. There are about 10 genera, with 15 species.

Eriobotrya (family Rosaceae) Genus of small trees including *E. japonica*, which yields the edible fruit the loquat. There are 30 species, occurring in the warm parts of Asia.

Eriocaulaceae Family of monocotyledonous herbs, in which the leaves are linear, borne mostly in a basal rosette. The flowers are tiny, in a bracteate head on a long stalk, unisexual but normally monoecious. There are nine genera, with 600 species. They have an almost cosmopolitan distribution but are absent from Europe except for western parts of the British Isles. Most are swamp or aquatic plants.

Eriocraniidae (order Lepidoptera) Family of small, primitive moths with a broad distribution but few species. The venation of the forewing and hindwing is similar. Mandibles are reduced but distinct, and there is a short proboscis. Adults are day fliers. Larvae are leaf-miners and often legless. Pupae have large, curved mandibles, and pupation occurs in the soil in a strong cocoon.

Eriostemon (wax flowers; family Rutaceae) Genus of shrubs which have simple, alternate leaves with oil glands. The flowers are axillary or terminal, solitary, and white, pink, or blue. The five-pointed sepals form a large calyx, and the five petals are spreading and waxy, usually arranged in a star-like form. The 10 woolly stamens are arranged closely around the pistil. The fruit is composed of five separate carpels with a single black, shiny seed. There are 30–40 species, all of them endemic to Australia, where they are present in all temperate regions.

Erithacus *See Luscinia*.

ermines *See* Arctiidae.

erosion 1 The part of the overall process of denudation that includes the physical breaking down, chemical solution and transportation of material. 2 Movement of soil and rock material by agents such as running water, wind, moving ice, and gravitational creep (or mass movement).

erosional scarp *See* scarp.

erosion gully Feature of rain erosion that develops from the run-off of a violent torrent that bites deeply into topsoil and soft sediments.

erosion surface Gently undulating land surface that cuts indiscriminately across underlying geological structures and that is the end-product of a long period of erosion. Different types are produced under different environments. Among the more important are the peneplain (humid temperate), etchplain (humid tropical) and pediplain (semi-arid). Marine processes may also cut an erosion surface.

Erotylidae (pleasing fungus beetles; class Insecta, order Coleoptera) Family of shiny, oval beetles, 2–23 mm long, and often brightly coloured. The head is prognathous, with a three-segmented, flattened club. Larvae are pale and elongate, with toughened spiny plates. Legs are well developed, antennae three-segmented. The beetles are found in trees, where they feed on fungal material. *Triplax* species are associated with the bracket fungus *Polyporus*. There are 1500 species.

Errantia (scaleworms, sea mice; phylum Annelida, class Polychaeta) Subclass of polychaete worms which have a large number of body segments, those of the head and posterior differing from the rest. The mouth often has several paired jaws. Most are vagile predators, others adopt a burrowing mode of life. They are first recorded from the Cambrian.

erratic Glacially transported rock whose lithology shows that it could not have been eroded from the local country rock. An example is the occurrence near Snowdonia, Wales, of granites derived from Scotland. An 'indicator' is an erratic whose origin can be located precisely.

erumpent Bursting through.

Erwinia (family Enterobacteriaceae) Genus of Gram-negative, rod-shaped bacteria which are typically motile with many flagella. They are found as saprotrophs or parasites in association with plants. The genus includes some important plant pathogens, e.g. the causal agent of fireblight.

Eryngium (sea holly; family Umbelliferae, subfamily Saniculoideae, tribe Saniculeae) Genus of shrubby, often spiny, perennial herbs which are unlike the characteristic umbellifers in appearance. The lobed or deeply-cut leaves are toothed and without stipules. The sessile flowers are held in a dense head surrounded by leafy, spiky, and showy bracts. The calyx teeth are often sharp, rigid, and longer than the petals. The five petals are narrow and notched, with free stamens, and an inferior ovary with two unilocular carpels. The fruit is a two-celled schizocarp, which splits into two single-seeded fruits. There are more than 200 species, found in temperate and tropical regions, where they are often found in arid conditions.

erysipelas Disease of humans in which red, inflamed patches develop on the skin (especially on the face) and on mucous membranes. The condition is caused by *Streptococcus pyogenes*, which infects via wounds.

Erysipelothrix Genus of bacteria which are not assigned to a taxonomic family. The cells are rod-shaped to filamentous, non-motile, and typically Gram-positive. Growth occurs only in the

presence of air. There is one species, which is parasitic on mammals, birds and fish; it can be pathogenic.

Erysiphaceae (order Erysiphales) Family of fungi which includes the plant parasites known as powdery mildews. The foliage of an infected plant has a mealy appearance due to the production by the fungus of conidia. There are several genera.

Erysiphales (class Pyrenomycetes) Order of fungi, sometimes classified in the Plectomycetes, in which the mycelium typically is colourless and the fruit bodies are usually dark-coloured, spherical or hemispherical cleistothecia. Commonly, two families are recognized. All members are parasites of higher plants and some can cause diseases of economic importance.

Erysiphe (family Erysiphaceae) Genus of fungi which includes some economically important plant parasites. *E. graminis* is responsible for mildew of grasses and cereal crops. The species occurs in a number of forms, each specifically attacking a particular type of host plant.

Erythrina (family Leguminosae, subfamily Papilionatae) Genus of small, quick-growing, soft-wooded trees which have spiny branches, and leaves with a few big leaflets. The flowers are large and showy, and are bird-pollinated. They are grown as ornamentals and make good living fences. There are 100 species, occurring in tropical and subtropical, mainly seasonal climates.

Erythrinidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish which have a long gape, a single dorsal fin opposite the pelvic fins, and a rounded tail-fin. There are about five species, occurring in S. America.

erythrism In mammals, the possession of red hair, caused most commonly by a lack of black pigment (eumelanin) which allows the red pigment (phaeomelanin) to dominate.

erythrocyte Red blood cell. *See also* anucleate.

erythromycin *See Streptomyces.*

Erythroxylum (family Erythroxylaceae) Genus of trees and shrubs, in which the leaves are simple with persistent longitudinal folds. *E. coca* of the Andes is the source of cocaine, obtained from the leaves. There are 250 species, occurring in tropical and subtropical regions, mainly of America and Madagascar.

Escalloniaceae (order Rosales) Often classified as a subdivision of the Saxifragaceae, the Escalloniaceae is a family of shrubs with simple, alternate leaves, some species being evergreen. The flowers are small, greenish, and borne in catkins. The fruit is a capsule. Most are from S. America and Australia.

escarpment *See* scarp.

Escherichia (family Enterobacteriaceae) Genus of Gram-negative, rod-shaped bacteria, comprising one species (*E. coli*), with many strains. *E. coli* is the most thoroughly studied of all bacteria. It is found mostly in the lower gut of mammals, but also occurs in, e.g. sewage-contaminated natural waters; it is commonly used as an indicator of sewage pollution. A few strains are pathogenic, causing, for example, dysentery in infants.

Eschrichtiidae (order Cetacea, suborder Mysticeti) Family of baleen whales with one member, *Eschrichtius*, the grey whale. The baleen plates are short and narrow, and the left and right rows are separated at the front of the mouth. The snout is blunt; typically there are two grooves on the throat; and the body is slender. Grey whales are mostly grey in colour but with white mottling; they grow to a length of 11–15 m. They are seasonal migrants within the N. Pacific and feed on benthic amphipods.

Eschrichtius (grey whale) *See* Eschrichtiidae.

escutcheon Depressed area, variable in shape, which is found to the posterior of the beaks of certain pelecypods.

esker Long, sinuous, steep-sided, narrow-crested ridge which consists of cross-bedded sands and gravels. It is laid down by glacial meltwater (outwash), either at the edge of a retreating ice sheet, or in a subglacial or englacial ice tunnel. A supraglacial origin, in channels parallel to the ice sheet, has been proposed recently.

eskimo curlew (*Numenius borealis*) *See Numenius.*

Esocidae (pike, muskellunge; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of freshwater fish, which have a streamlined body, a produced, duck-like snout, and a large mouth containing numerous sharp teeth. The anal and single dorsal fins are located to the rear of the body, near the tail. Adult pike tend to be aggressive, solitary individuals. Restricted to the northern hemisphere, *Esox lucius* (European pike) ranges from Ireland, across Europe to E. Siberia, and right across N. America. Other species, including *E. masquinongy* (muskellunge), are found only in N. America. Female European pike can grow to a length of 1.5 m. All species are highly regarded by anglers. There are about five species.

Esox lucius (European pike) *See* Esocidae.

Esox masquinongy (muskellunge) *See* Esocidae.

esparto grass (*Stipa tenacissima*) *See Stipa.*

Espeletia (family Compositae) Genus of characteristically weird paramo plants which have a short, stout stem, and crowded, terminal, hairy leaves. There are 80 species, occurring in the Andes.

espundia Disease of humans, which occurs in S. America. It is primarily a disease of the mucous membranes, with ulcers developing in the mouth, nose, etc. The causal agent is a protozoon, *Leishmania brasiliensis*, which is transmitted by sandflies (*Phlebotomus*) or which may infect via wounds.

essential element Chemical nutrient that is vital for the successful growth and development of an organism. Elements needed in relatively large

amounts are termed macronutrients; those needed only in small or minute quantities are called micronutrients or trace elements. Macronutrient elements include carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, magnesium, and calcium. Important micronutrient elements include molybdenum, iron, magnesium, and boron.

essexite Name given to a variety of alkali gabbro (originally from Massachusetts), which contains titan-augite, olivine, nepheline, with or without analcite, alkali feldspar, and labradorite. *See also* basic rocks.

established cell line Cell line derived from a primary culture which may be subcultured indefinitely *in vitro*. An example of an established cell line is HeLa cells, an aneuploid strain of human epithelial-like cells derived culturally in 1952, from a piece of tissue from a carcinoma of the cervix. (The name 'HeLa' is derived from the first two letters of the forename and surname of the patient from whom the cells were taken).

ester Compound formed as the condensation product (i.e. water is removed) of an acid and an alcohol; water is formed from the OH of the acid and the H of the alcohol.

estivation *See* aestivation.

estovers (common of) 1 Right to gather lying and dead standing wood, usually up to a stated size, for firewood on common land. Dead standing wood and branches can be obtained 'by hook or by crook', i.e. by the use of a blunt tool. 2 Firewood, timber, and other materials taken from common land as a privilege.

Estrildidae (waxbills, mannikins, munias; order Passeriformes) Varied family of small, brightly coloured finches with rounded wings, and medium to short tails. They have small to large, short, conical bills and strong feet. They are gregarious. They inhabit forests, grassland, and desert, feed on seeds and insects, and build an enclosed nest with a side entrance, usually in trees. Nestlings have decorated palates and tongues. There are 27 genera, with 138 species, most of which are popular cage birds, found in Africa, S. Asia, Australasia, and Pacific Ocean islands.

estrogen *See* oestrogen.

estuarine crocodile *See Crocodylus porosus*.

estuary Semi-enclosed coastal body of water which has a free connection with the open sea and where fresh water, derived from land drainage, is mixed with sea-water. Estuaries are often subject to tidal action and where tidal activity is large, ebb and flood tidal currents tend to avoid each other, forming separate channels. In estuaries where tidal activity is small, the invading dense sea-water may flow under the lighter fresh water forming a salt wedge. A positive estuary is one in which surface salinities are lower within the estuary than in the open sea due to fresh water inflow exceeding outflow caused by evaporation. A negative estuary is one in which evaporation exceeds fresh water inflow and therefore hypersaline conditions exist in the estuary. Normally an estuary is a result of valley drowning by the postglacial rise in sea-level. The action of tidal currents on the large amount of available sediment may give rise to a range of mobile bottom forms, including ebb and flood channels, sand banks, and sand waves.

-etalia *See* Zurich–Montpellier phytosociological school.

etchplain Plain produced in a tropical or subtropical environment as a result of a phase of deep chemical weathering during tectonic stability, followed by one of erosion in which the weathered debris is stripped away. Etchplain relief reflects differences in the resistance of the bedrock to weathering.

-etea *See* Zurich–Montpellier phytosociological school.

etesian winds Greek name for north-easterly, easterly, northerly, or north-westerly winds which blow between May and September in the Aegean Sea. The equivalent Turkish term is 'meltemi'.

ethene (ethylene) Gas (C_2H_4) which is produced naturally by plants and which functions as a hormone in the control of such processes as germination, cell growth, fruit ripening, senescence, and abscission. It is also involved in the response of a plant to gravity and to stress.

Ethiopian faunal region Area which corresponds with sub-Saharan Africa, although it is not completely separated from the neighbouring faunal regions; generally it is taken to include the south-west corner of the Arabian peninsula. Varied game animals are found there; and there are a number of endemic families, including various rodents and shrews, giraffe, hippopotamus, aardvark, tenrec, and lemurs.

ethological isolation (sexual isolation) Failure of individuals of species with recent common ancestry (i.e. related species or semispecies) to produce hybrid offspring because differences in their behaviour prevent successful mating taking place.

ethology The scientific study of the behaviour of animals.

ethylene *See* ethene.

etiolation The state of plants that have been grown in the dark: they are not green, having little or no chlorophyll, and have very long internodes and rudimentary leaf growth.

etioplast Organelle that develops from chloroplast proplastids in the absence of light.

Etmopterus spinax (Atlantic velvet belly) *See* Squalidae.

-etosum *See* Zurich–Montpellier phytosociological school.

-etum Suffix used in the Zurich–Montpellier phytosociological scheme to denote a community of association rank. Applied to the generic name of the most characteristic species, i.e. that which differentiates the association from others in the same alliance. A heathland community typified by

Calluna vulgaris thus becomes Callunetum. *See also* differential species.

eu- Prefix meaning 'well', 'good', etc. It is used in ecology to denote, in particular, enrichment or abundance, e.g. 'eutrophic', nutrient-rich; 'euphotic', light-rich.

Eucalyptus (family Myrtaceae) Huge genus of trees which impart a distinctive aura to Australian forests. Their leaves are held vertically, and are commonly glaucous and resinous. The calyx forms an operculum which is thrown off when the flower opens. The receptacle is hollow, and woody in the fruit. There are many stamens. The fruit is a capsule. There are many seeds. Many eucalypts are widely cultivated as fast-growing timber trees. Jarrah is *E. marginata*; karri is *E. diversifolia*; bluegum is *E. regnans*, the tallest tree in the world. There are 500 species, most of which are confined to Australia.

eucalyptus woods Variants of the mid-latitude broad-leaved evergreen forest, found in SW and SE Australia, which are dominated by the gum tree (*Eucalyptus* species). The gum trees cast a light shade, thus allowing the establishment of a significant ground flora.

eucarpic Applied to a fungus in which only part of the thallus differentiates to form a reproductive structure or structures.

Eucarya *See Santalum*.

Eucera *See* Anthophoridae.

euchromatin *See* heterochromatin.

Eucoccidia (subclass Coccidia) Order of protozoa, which live parasitically inside the cells of an animal host. Schizogony occurs, and syzygy occurs in some species. There are three suborders, and the genera include some important disease-causing organisms.

Eucommiaceae Family of one species of tree, which is native to China, and known only in cultivation. The flowers are unisexual, without a perianth. The bark latex is a source of gutta percha.

Eucryphia (family Eucryphiaceae) Genus of trees or shrubs, related to Cunoniaceae, which are evergreen, with opposite, simple or pinnate, stipulate leaves. The flowers are showy. Several are valuable ornamentals. There are five or six species, occurring in Chile and Australia.

Euechinoidea (class Echinoidea) Subclass of sea-urchins in which the normally rigid test is composed of ambulacra and interambulacra, made up of two columns of plates. Sphaeridia are present. The subclass includes both regular and irregular types of echinoid. They first appeared in the Upper Triassic.

Eufriesia (neotropical orchid bees) *See* Apidae.

Eugeissona (family Palmae) Genus of palms, which are clump-forming, with a stout, branched, underground rhizome, and mostly stemless rosettes of spiny, pinnate leaves. Most of the trees are massive. The inflorescence is tall and narrow. The flowers are paired, one male, one female; the petals woody, long, and pointed. The ovary has three ovules, which are incompletely trilocular. The fruits are finely scaly, and the outer fibrous and inner stony wall have a basal pore. The fruit contains a single seed. There are about five species, occurring in rain forests of Malaya and Borneo.

Eugenia (family Myrtaceae) Genus of trees, closely similar to *Syzygium*, in which the leaves are opposite, and have a distinct submarginal nerve, and no stipules. The calyx cup has four or five sepals, four or five petals, and many stamens; and the ovary is inferior. The fruit is a berry. The timber is hard. Some produce an edible fruit. There are about 1000 species, with a pantropical distribution.

eugenics Postulated method of improving humanity by altering its genetic composition. It would involve encouraging the breeding of those presumed to have desirable genes (positive eugenics), and discouraging the breeding of those presumed to have undesirable genes (negative eugenics). It relies upon the notion of 'desirable' and 'undesirable' genotypes and assumes that selection for these can be particularly applied. Neither concept is generally accepted as valid, the former because it is often a value judgement that will vary between individuals, societies, and circumstances; the latter because genotypes are often present in the heterozygous state and so are not readily detected. Every human is heterozygous for several different deleterious recessive genes, so that if these were detectable, *no one* would be allowed to breed under such a programme.

eugeosyncline The part of a geosyncline that is characterized by the presence of volcanism and plutonism. Geosynclinal theory has required some reinterpretation and modification in the light of the newer, unifying theory of plate tectonics.

Euglena (class Euglenophyceae) Genus of unicellular, green, photosynthetic algae. The cell body is typically spindle-shaped but is capable of broadening and narrowing to some extent; it is motile with a single flagellum. *Euglena* is common in all freshwater habitats, especially when these are slightly polluted with organic matter.

Euglenophyceae Class of typically unicellular algae characterized by the possession of a single flagellum, the formation of paramylum as a storage product, possession of chlorophylls *a* and *b*, and the absence of sexual reproduction. There are six orders, with many genera, the best known of which is *Euglena*. They are found in a wide range of aquatic habitats: ditches, ponds, puddles, and rivers (especially those polluted with organic matter). Some species occur in brackish or marine waters.

Eugloss (neotropical orchid bees) *See* Apidae.

Eugnathina (starfish; subclass Asteroidea, order Spinulosida) Suborder of spinulosan starfish, in which the 10 plates surrounding the mouth (mouth angle plates) are large and bear many spines. The ambulacral grooves are wide. They are known from the Ordovician to Recent.

Eugregarinida (subclass Gregarinia) Order of protozoa which are common as parasites in annelids

and arthropods. Schizogony does not occur; syzygy does occur. There are two suborders, several families, and many species.

euhaline *See* brackish.

eukaryote Organism with cells that have a distinct nucleus, i.e. all protists, fungi, plants, and animals. The first eukaryotes were almost certainly green algae, and what appear to be their microscopic remains appear in Precambrian sediments dating from a little less than 1500 million years ago.

Eulaema (neotropical orchid bees) *See* Apidae.

eulamellibranchiate Applied to a specialized type of gill structure, common in pelecypods, in which the gill filaments are united by cross-members, forming sheets of tissue, and partitioning the gill space into vertical tubes through which water passes. Blood vessels are arranged vertically along the tissue junctions.

eulittoral zone In marine ecosystems, the main area of the littoral zone lying below the littoral fringe. Barnacles are the most characteristic animals on rocky shores, with mussels and oysters also typical; the green algae *Enteromorpha* and *Ulva* species are common too. On sandy shores burrowing animals are common, e.g. shrimps, crabs, and polychaete worms (such as the lugworms, *Arenicola* species).

Eulophidae (suborder Apocrita, superfamily Chalcidoidea) Large and common family of insects, most of which are 1–3 mm long, and black or brightly metallic. They are unique among the Chalcidoidea in that some species, on approaching maturity, spin silken cocoons on or close to the host larvae. Some eulophids are parasites of leaf-miners, coleopteran larvae, Lepidoptera, Diptera, aphids, scale insects, and whiteflies. Others are hyperparasites of braconids.

Eumastacidae (class Insecta, order Orthoptera, superfamily Acridoidea) Family of primitive, slender, wingless or brachypterous, short-horned grasshoppers, which includes the monkey and morabine grasshoppers. Most of the 120 or so species are tropical.

Eumenes coarctata (heath potter wasp; superfamily Vespoidea, family Eumenidae) Species of wasp, which makes small, pot-like nests attached to heather stems, in which eggs and paralysed caterpillars are placed.

Eumenidae (mason wasps, potter wasps; suborder Apocrita, superfamily Vespoidea) Family of solitary, predatory wasps, whose adults make flask-shaped nests of clay and small pebbles glued together with saliva. Most adults are 10–20 mm long, marked with black, yellow, or white, and have elongate, knife-like mandibles. A large and widely distributed group, it is sometimes regarded as a subfamily of the Vespidae. All species provision their nests with paralysed lepidopteran, symphytan, or coleopteran larvae.

Eumeninae *See* hunting wasps.

Eumycota ('true fungi') Division containing those fungi that do not form a plasmodium or pseudoplasmodium, i.e. all fungi excluding the slime moulds and their allies.

Eunectes murinus (anaconda; order Squamata, suborder Serpentes (Ophidia), family Boidae) The largest living snake, which is said to reach 11 m in length. It is olive-green in colour, with black spots above, and a mottled, yellowish belly. It is exclusively aquatic. Mainly it eats terrestrial mammals that come to drink. It occurs in swamps and rivers throughout tropical S. America east of the Andes, and in Trinidad.

Euodia (family Rutaceae) Genus of trees or shrubs in which the leaves are opposite, usually with three leaflets, and are aromatic when crushed. The fruits are follicular, with black, glossy seeds. There are 100 species, occurring in the Mascarenes, and from Indo-Malaysia to China and the Pacific islands.

Euonymus europaeus (spindle tree) *See* Celastraceae.

Eupantotheria (class Mammalia, subclass Theria, infraclass Pantotheria) Order of extinct mammals known from the Jurassic of N. America and Europe; and in its earliest, Middle Jurassic, form (*Amphitherium*) only from the lower jaw. The jaw identifies it as mammalian, and possibly ancestral to later pantotheres.

Euparkeria Bipedal thecodont (or 'tooth-in-socket') reptile known from the Lower Triassic. The thecodonts are considered to be ancestors of the dinosaurs and, apart from a limited number of primitive features in the skull, *Euparkeria* is a likely ancestor for most archosaurian stocks. It was a small reptile, only 60–100 cm in length.

Eupatorium (family Compositae) Genus of herbs, which includes *E. odoratum*, a noxious tropical weed (siamweed). There are 1200 species, mostly American, but a few occurring elsewhere.

Eupetes (rail-babbler; family Timaliidae) Monotypic genus, comprising *E. macrocercus*. This is a slender, chestnut-brown bird, with a thin head and neck, a long straight bill, and long legs. It has a long white eyebrow above a black facial band, and a bare blue neck patch. It is terrestrial, and inhabits forests; it runs rapidly along the ground, and feeds on insects. It is found only in Malaysia and parts of Indonesia.

Eupetes macrocercus (rail-babbler) *See Eupetes*.

Euphaeidae *See* Epallaginidae.

Eupharynx pelecanoides (gulper) *See* Eurypharyngidae.

Euphonia (euphonias; family Thraupidae) Genus of small, brightly coloured tanagers, in which the males are glossy black above, and yellow or orange below. They have short, stout bills, and short tails. They inhabit forests and clearings, and feed on insects and fruit, particularly mistletoe berries. Their nests are enclosed with a side entrance, built in trees. There are 25 species, found in C. and S. America, and the West Indies.

Euphorbia (spurges; family Euphorbiaceae) Genus of plants with a very distinctive, compound inflorescence of tiny flowers without perianths, grouped in umbel-like cymes: several male flowers, each with one stamen, are grouped within an

involucre, and the one female flower consists of a stalked three-celled ovary. The fruit is an explosive capsule. In temperate Europe most are herbs with leafy stems. In the tropics, especially in Africa, many are trees or shrubs, often stem-succulents and cactus-like, but differing from cacti in their latex and twinned spines. All produce an acrid, milky juice. *Euphorbia* is a large genus, with 1600–2000 species, found in most temperate and tropical regions.

Euphorbiaceae Huge family mostly of trees and shrubs but a few herbs, a minority of which have latex. The leaves are simple, usually with stipules. The flowers are usually tiny and unisexual, with petals usually absent, and the ovary having three chambers, each with two pendulous ovules. The fruit is typically a three-lobed woody capsule. The seeds sometimes have a fleshy jacket. There are 300 genera, with 5000 species, and they are cosmopolitan in distribution.

Euphoria (family Sapindaceae) Genus of trees and shrubs including *E. longana*, which is cultivated for its fruit, the longan. There are 15 species, occurring from India and S. China to Malesia.

euphotic zone The upper, illuminated zone of aquatic ecosystems: it is above the compensation level and therefore the zone of effective photosynthesis. In marine ecosystems it is much thinner than the deeper aphotic zone, typically reaching 30 m in coastal waters but extending to 100–200 m in open ocean waters. In freshwater ecosystems it is subdivided into littoral (shallow edge) and limnetic zones. *Compare* aphotic zone; dysphotic zone; photic zone; and profundal zone.

Euphrasia (family Scrophulariaceae, subfamily Rhinanthoideae) Genus of annual herbs, with small, opposite or alternate leaves, which are semiparasitic on grasses. The bisexual flowers are usually white, blue, or pink, and are held in the upper leaf axils. They are sessile, and often appear to form a terminal spike with reduced leaves between each flower and the next. The bell-shaped calyx is four-lobed. The upper tip of the corolla is incurved, with two reflexed lobes; the lower lip is three-lobed. There are four stamens. The ovary is superior, with two fused capsules, two locules, and a single style. The fruit is a dry capsule with numerous small seeds. The species hybridize readily. There are about 150 species, found in all temperate regions of the world.

Euplectes (bishops, whydahs; family Ploceidae) Genus of weavers with red or yellow and black males, some long-tailed; and brown females. They have stout, seed-eating bills, and inhabit grassland, swamps, and clearings. Their nest is an enclosed dome, built in bushes or grass. There are 16 species, found in Africa; most are popular cage birds.

euploid Cell having any number of complete chromosome sets, or an individual composed of such sets. It is thus a polyploid with a chromosome number that is an exact multiple of the basic number for the species from which it originated.

Eupodotis (bustards; family Otidae) Genus of medium-sized bustards, some with black or bluish throats. They inhabit deserts, plains, grassland, and scrub. There are 5–7 species, found in Africa.

Eupomatiaceae Small family of shrubs and trees in which the leaves are alternate, simple, and without stipules. The flowers are showy, solitary, and bisexual. The perianth is fused; the upper part becomes a conical lid, and the lower a receptacle with the stamens attached to the rim. The inner stamens are petal-like and sterile, the others are pointed. The carpels are sunk into the receptacle, each with several ovules. The fruit is a berry with oil-glands, and contains several angular seeds with copious endosperm. There is only one genus (*Eupomatia*) and two species. *E. laurina* gives a decorative wood. Both species are restricted to the rain forests of E. Australia and SE Asia.

Eurasian water spider (*Argyroneta aquatica*) *See* Agelenidae.

Eurglossinae *See* Colletidae.

European angler (*Lophius piscatorius*) *See* Lophiidae.

European army worm *See* Sciaridae.

European chameleon *See Chamaeleo chamaeleon.*

European earwig (*Forficula auricularia*) *See* Forficulidae.

European frog *See Rana temporaria.*

European glass lizard *See Ophisaurus apodus.*

European grenadier (*Coryphaenoides rupestris*) *See* Macrouridae.

European hake (*Merluccius merluccius*) *See* Merluccidae.

European hornet *See Vespa crabro.*

European ling *See Molva molva.*

European lobster *See Homarus gammarus.*

European pike (*Esox lucius*) *See* Esocidae.

European pond terrapin *See Emys orbicularis.*

European pond tortoise *See Emys orbicularis.*

European smelt (*Osmerus eperlanus*) *See* Osmeridae.

European sole (*Solea solea*) *See* Soleidae.

European toad *See Bufo bufo.*

European tree frog *See Hyla arborea.*

European turbot (*Scophthalmus maximus*) *See* Bothidae.

European whip snake *See Coluber viridiflavus.*

Eurosiberian floral region Part of Good's (1974) Boreal kingdom: an extensive region, in which the flora of the western part is richer than that of the eastern part. Whereas Europe has roughly 150 endemic genera, Siberia apparently has only about 12, almost all of which are monotypic. The contrast between the two subregions reflects primarily the different climatic regimes.

Eurotiaceae (order Eurotiales) Family of fungi in which ascocarps vary from an unenclosed cluster of asci to fruiting structures in which the asci are enclosed by a hard resistant wall. The family includes the perfect (sexual) stages of important genera such as *Aspergillus* and *Penicillium*.

Eurotiales (class Plectomycetes) Order of mycelium-forming fungi which are mainly saprotrophic and are found in a very wide range of habitats, including soil, wood, dung, and animal debris (such as hair, horn, and feathers). Some members are important in that they cause spoilage of certain foods; others are used in certain industrial fermentations. A few members can cause disease in animals. There are nine families.

eury- Prefix used in ecology to describe species with a wide range of tolerance for a given environmental factor, e.g. 'euryecious', having a wide range of habitats. *Compare* steno-.

Euryapsida Reptiles, which have a single, upper temporal opening behind the eye. The group includes the plesiosaurs, nothosaurs, and placodonts. The ichthyosaurs had a similarly-placed opening, but there were key differences in the arrangement of the bones forming its margins: for this and other reasons, the ichthyosaurs are usually placed in a different subclass from the euryapsids, the Ichthyopterygia. However, like the ichthyosaurs, the euryapsids were typically aquatic types, especially from the mid-Triassic onwards. Euryapsids first appeared in the Permian and became extinct at the end of the Mesozoic.

euryecious Having a wide range of habitats. *See* eury-.

Euryhalina (brittle-stars; subclass Ophiuroidea, order Phrynophiurida) Suborder of brittle-stars in which the small disc lacks plates. Both the arms and the disc are completely covered with a thick skin. Vertical enrolling of the branched arms may result in a basket-like form. The suborder is known from the Devonian to Recent.

euryhaline Able to tolerate a wide range of degrees of salinity. *See* eury-.

Eurylaimidae (broadbills; order Passeriformes) Family of small to medium-sized, brightly coloured birds, most having a whitish dorsal patch. Their bills are large, broad, flattened, and hooked, often covered by a short crest. They have large heads, rounded wings, and short to long tails. They inhabit open wooded country, and feed on insects, fruit, seeds, and small vertebrates. Their nests, which are suspended over water, are pear-shaped with a side entrance. There are eight genera, with 14 species, found in Africa, S. Asia, Indonesia, and the Philippines.

Eurylaimus (broadbills; family Eurylaimidae) Genus of rather dull broadbills with yellow or blue on the wing. *E. steerei* (wattled broadbill) has a large blue wattle round its eye. There are three species, found in SE Asia, Indonesia, and the Philippines.

Eurylaimus steerei (wattled broadbill) *See Eurylaimus*.

Eurymylidae (cohort Glires, order Lagomorpha) Extinct family of rabbit-like mammals, known from the Upper Palaeocene of east Asia.

euryoxic Able to tolerate a wide range of concentrations of oxygen. *See* eury-.

euryphagic Using a wide range of types of food. *See* eury-.

Eurypharyngidae (gulper; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Family of deep-sea fish which have an enormous mouth capable of accommodating very large prey animals. The body itself tapers down toward a very thin tail region. Living at depths of more than 2000 m, the large mouth presumably is an adaptation to scarcity of food in that region The relatively common *Eupharynx pelecanoides* (gulper) is not a large fish, rarely exceeding 60 cm in length.

eurypterid *See* Merostomata; and *Pterygotus deepkillensis*.

Eurypyga helias (sunbittern) *See* Eurypygidae.

Eurypygidae (sunbittern; order Gruiformes) Monotypic family, comprising *Eurypyga helias*. This is a grey, brown, and white, barred and mottled bird with a large head; a long slender neck; long bill, legs, and toes; and broad wings which show a central orange area when spread. It is found by forest streams and ponds, feeds on insects and crustaceans, and nests in a tree or bush. It is found in C. and S. America.

eurythermal Able to tolerate a wide temperature range. *See* eury-.

Euscorpius flavicaudis *See* Scorpiones.

Euscorpius germanus *See* Scorpiones.

Eusideroxylon (family Lauraceae) Genus of trees which yield very hard, durable timber, valuable for houseposts and shingles. There are two species, found in Borneo. *E. zwageri* is Borneo ironwood (belian).

eusocial Highly social.

eusporangiate In ferns, applied to the supposedly primitive, massive, stout-stalked, thick-walled type of sporangium. This arises from more than one parent cell; and lacks the specialized annulus or ring of thickened cells that is present in the leptosporangiate, supposedly more advanced ferns. (The latter have delicate, thin-walled, and thin-stalked sporangia.)

Eustachian canal In tetrapods, a tube connecting the pharynx with the middle ear. It permits the equalization of air pressure to either side of the tympanic membrane and so prevents distortion of the membrane.

eustatic Applied to the worldwide changes in sea-level caused by tectonic movements or by the growth or decay of glaciers (glacio-eustasy, or glacio-eustatism).

Eusthenopteron Genus of lobe-finned, crossopterygian fish known from the Devonian of Europe and N. America. *Eusthenopteron* exhibits a number of advanced characters which suggests that it is closely

linked with the evolution of the Amphibia. It had lungs and strong muscular fins, and is closely related to the lungfish and coelacanths.

Eutamias (chipmunk) *See* Sciuridae.

Euterpe (family Palmae) Genus of palms, many of which are large trees. The trunk is columnar, and sometimes slightly swollen. The leaves are pinnate, the crown-shaft is prominent. The plants are monoecious. *E. oleracea* of Brazil and Paraguay is the assai palm, whose fleshy fruit wall provides the popular plum-coloured beverage assai. There are 18 species, found in the W. Indies, and in C. and S. America.

Eutheria (class Mammalia, subclass Theria) The infraclass that includes all of the placental mammals, and which probably arose during the Cretaceous. The blastocyst develops an outer layer of cells which surrounds a small inner group from which the embryo develops. This is retained in the uterus, nourished by means of an allantoic placenta, and born in an advanced stage of development. In adults there is no pouch (marsupium); nor are there epipubic bones, the ilium, ischium, and pubis of the pelvic girdle being fused to form a single bone, the os innominatum. The tympanic bone may be ring-like or may form a bulla, but the alisphenoid bone never forms part of the bulla. There is no in-turned angle of the jaw.

eutrophic Applied to nutrient-rich waters with high primary productivity. Typically, eutrophic lakes are shallow, with a dense plankton population and well-developed littoral vegetation. The high organic content may mean that in summer, when there is stagnation due to thermal stratification, oxygen supplies in the hypolimnion become limiting for some fish species, e.g. trout. *Compare* oligotrophic.

eutrophication Process of nutrient enrichment in aquatic ecosystems. It occurs naturally over geological time, but may be accelerated by human activities, e.g. sewage disposal, or land drainage: such activities are sometimes termed 'cultural eutrophication'. The rapid increase in nutrient levels stimulates algal blooms. On death, bacterial decomposition of the excess algae may deplete oxygen levels seriously. This is especially critical in thermally stratified lakes, since the decaying algal material typically sinks to the hypolimnion where, in the short term, oxygen replenishment is impossible. The extremely low oxygen concentrations that result may lead to the death of fish, creating a further oxygen demand, and so leading to further deaths.

evagination The release of the contents of membranaceous vesicles to the exterior.

evanescent Temporary; soon disappearing.

Evaniidae (ensign wasps; suborder Symphyta, superfamily Evanioidea) Family of black symphytans, 3–15 mm long, which are somewhat spider-like in appearance. The small abdomen is carried on a long petiole, the thorax is very stout, and the coxae (first leg segments, which articulate with the thorax) are grooved to receive the long trochanters. Adults are found in association with Blattodea (cockroaches) whose oothecae (horny egg cases or capsules) they parasitize.

evaporimeter Device for measuring the rate of evaporation into the atmosphere from an exposed water surface in a tank set in the ground, or from a surface of porous material that is kept wet.

evaporite General lithological term applied to sedimentary rocks which have formed by the precipitation of salts from natural brines during evaporation of marginal salt-pans, lagoons, supratidal flats, and saline lakes. Common rock types are limestone, dolomite, anhydrite, gypsum, and rock salt.

evapotranspiration Combined term for water lost as vapour from a soil or open water surface (evaporation) and water lost from the surface of a plant, mainly via the stomata (transpiration). The combined term is used since in practice it is very difficult to distinguish water vapour from these two sources in water-balance and atmospheric studies.

evening primrose *See Oenothera*.

event recorder Instrument, invented by the British zoologist Richard Dawkins, used to record animal behaviour. The operator has a keyboard, similar to that of a small electronic organ, which permits a very large number of signals to be produced by the pressing of keys or combinations of keys. The signals are transmitted to a recording tape from which they can be read by a suitably programmed computer.

Everglades The low, flat plains area of S. Florida, USA, which is subject to periodic freshwater flooding. In summer the area becomes swampy, but in winter it is extremely dry. *Cladium effusum* is widespread. Scattered trees include palms, and pines occur on higher ground. Within the same area small, isolated, tropical rainforest communities, locally termed hammocks, are found. The coastal areas are renowned for mangrove swamp.

evergreen Applied to a tree or shrub that has persistent leaves, and whose crown is never wholly bare.

evergreen forest Forest in which there is no seasonal leaf fall (i.e. trees shed old leaves and produce new ones throughout the year, rather than during particular periods). The trees may be conifers, deciduous hardwoods, or both. The distribution of such forests ranges through boreal, middle and tropical latitudes. The northern coniferous forests and the equatorial rain forests are the most extensive evergreen forests. Evergreen coniferous forests predominate where the growing season is less than half the year; broad-leaved evergreen forest is found in regions that lack a prolonged dry season.

evergreen mixed forest Forest in which the dominant trees are both evergreen broad-leaved hardwoods and conifers. Such forests are particularly well developed in the southern hemisphere, in S. Africa, Tasmania, New Zealand, and Chile. In the northern hemisphere, the Mediterranean basin once contained large tracts of such forest, but most of it has long been cleared.

evergreen phanerophyte *See* phanerophyte.

everlasting daisies *See Helichrysum*; and *Helipterum*.

Evermanellidae (sabretooth; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine fish, which have a relatively large head with well-developed teeth in the upper and lower jaws, the eyes located above the jaws, and a single dorsal and an adipose fin. They are small (about 16 cm), rather fragile fish. There are about six species.

Evernia (family Usneaceae) Genus of lichens in which the thallus is more or less flattened, and sparsely to extensively branched, according to the species. There are six species, found on trees and less frequently on rocks.

eversible Capable of being everted (turned inside out).

Evo *See* Mimetidae.

evolute Applied to coiled cephalopod conchs, all the whorls of which are exposed.

evolution Change, with continuity in successive generations of organisms. The phenomenon is amply demonstrated by the fossil record, for the changes over geological time are sufficient to recognize distinct eras, for the most part with very different plants and animals.

evolutionary determinism Change in gene frequencies by directed or deterministic processes, in contrast with change due to random or stochastic processes. The relative importance of the two kinds of change in evolutionary development is uncertain.

evolutionary lineage Line of descent of a taxon from its ancestral taxon. A lineage ultimately extends back through the various taxonomic levels, from the species to the genus, from the genus to the family, from the family to the order, etc.

evolutionary rate Amount of evolutionary change that occurs in a given unit of time. This is often difficult to determine, for several reasons: for example, should the unit of time be geological or biological (the number of generations)? How should morphological change in unrelated groups be compared? In practice it is necessary to adopt a pragmatic approach, such as the number of new genera per million years. *See also* darwin.

evolutionary species *See* chronospecies.

evolutionary trend Steady change in a given adaptive direction, either in an evolutionary lineage or in a particular attribute, e.g. dentition. Such trends are often apparent in unrelated taxa. Formerly they were attributed to orthogenesis; now orthoselection or the contending theory of species selection are invoked.

exafference Stimulation of an animal as a result of factors external to the animal itself. *Compare* reafference.

exarate In some insects, applied to a pupa in which the appendages are free and able to move. *See also* Coleoptera; and Hymenoptera.

exchangeable ions Charged ions that are adsorbed on to sites—oppositely charged—on the surface of the adsorption complex of the soil (mainly clay and humus colloids). Exchangeable ions can replace each other on this surface, and are also available to plants as nutrients. Although cations (e.g. calcium and magnesium) are the most common, exchanging at negatively-charged sites, some anions (e.g. sulphate and phosphate) do exchange at positively-charged sites. *See* anion-exchange capacity; and cation-exchange capacity.

exchange capacity Total ionic charge of the adsorption complex in the soil that is capable of adsorbing cations or anions.

exchange pairing The type of pairing of homologous chromosomes that allows genetic crossing-over to take place.

exchange pool *See* active pool.

excipulum Cup-shaped layer of sterile tissue that contains the hymenium in an apothecium.

exclusion principle Principle, introduced by Gause, that two species cannot coexist in the same locality if they have identical ecological requirements.

exclusive species In phytosociology, the optimum-fidelity class 5, i.e. a species that is confined completely or almost completely to a particular community. *Compare* accidental species; indifferent species; preferential species; and selective species.

excurrent Of, for example, a leaf: having a midrib that projects beyond the tip.

exfoliation Weakening and separation of the surface layers of rock as a result of chemical or (possibly) thermal weathering, or of pressure release. The decomposition of biotite and hydration of feldspar in granite causes swelling that may lead to failure. Expansion and rock fracturing may also result from temperature change (although this is questioned by many geologists), and sheet failure may result from the release of internal stress in massive rocks when an overburden is removed. *See also* thermoclastis.

exhumation Exposure, by subsequent erosion, of an ancient land-form or landscape that had been buried beneath younger rocks or sediment.

Exidia (order Tremellales) Genus of fungi in which the fruit body is gelatinous and variously shaped. There are many genera. *E. glandulosa* (*E. plana*) forms black, rubbery fruit bodies on dead logs, stumps, etc. *See also* witches' butter.

exine Outer, decay-resistant coat of a pollen grain or spore. The exine is characteristic for different plant families and genera, and sometimes even for different species. Hence it forms the basis for the identification and quantitative analysis of the vegetation composition of peats and other suitable sedimentary deposits dating back many thousands of years. *See also* palynology.

Exobasidiales (subclass Holobasidiomycetidae) Order of fungi which are obligately parasitic on higher plants. Basidia are arranged in a hymenium, but there is no true basidiocarp. There is one

family, with five genera, found on a wide range of plants. Some species cause disease in cultivated plants.

exobiology The biology of outer space: a study currently limited to the seeking of evidence for the existence of life beyond the Earth, and speculation on the possible alternative forms of such life.

Exocarpus (family Santalaceae) Genus of shrubs and small trees in which the leaves are reduced to small scales. The roots usually cling to other plants, on which they are semi-parasitic. The scale-like leaves are opposite or alternate. The flowers, held in short spikes or clusters in the leaf axils, are small and cream-coloured, and have four or five perianth segments. The fruit is a nut with a fleshy stalk. There are 26 species, found in SE Asia, Australia, and New Zealand, of which nine are endemic to Australia, some of them being distributed widely.

exoccipitals One of the bones situated to either side of the foramen magnum of the skull, in mammals forming the condyles.

Exocoetidae (flying fish, halfbeak; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Large family of marine and freshwater fish, all of which have streamlined bodies and spineless fins. The single dorsal and anal fins are set far back on the body, close to the forked tail-fin. Typically, all flying fish have greatly expanded pectoral fins, the tips of which may extend to the tail base. One of the more widely distributed species is the cosmopolitan *Exocoetus volitans* (flying fish), reaching a length of 25 cm. The halfbeaks have no expanded pectoral fins, but can be recognized by the elongated lower jaw, which in several species is at least three times the length of the upper jaw. The lower jaw is thought to scoop up minute animals as the halfbeak skims along the surface. One of the largest species, *Hemirhamphus far*, may reach 60 cm; most of the smaller species can be used as bait. There are about 108 species, distributed worldwide.

Exocoetus volitans (flying fish) *See* Exocoetidae.

exocrine *See* ectocrine.

exocuticle *See* exoskeleton.

exocytosis Process by which a membrane-bound vacuole fuses with the plasma membrane and thus discharges its contents outside the cell. As well as a mechanism for the removal of wastes, it is commonly employed for the secretion of cell products.

exodermis *See* hypodermis.

exoenzyme Enzyme that is discharged outside the cell.

exogenetic Applied to the various processes of erosion, transport, and deposition that take place at the Earth's surface. Usually the term is used in contrast with the 'endogenetic' or internal mechanisms.

Exomalopsis *See* Anthophoridae.

exopeptidase *See* protease.

exopod In Crustacea, the outer ramus of the biramous limb.

exopterygote Applied to an insect in which the wings develop externally and gradually. The insect undergoes no pupal stage or rapid metamorphosis, and its young are called 'nymphs'.

exoskeleton (cuticle) The secreted, horny skeleton that encloses the body of all arthropods. It is secreted by an underlying cellular layer called the hypodermis. The outermost layer is the epicuticle, comprising proteins and often waxes. Internal to the epicuticle is the procuticle, comprising an outer exocuticle and an inner endocuticle. Both are composed of a complex glycoprotein formed from the binding of chitin with protein; the molecular structure of the exocuticle is further stabilized by phenolic tanning and additional cross-linkages. In the Crustacea, the procuticle is also impregnated with mineral salts, calcium carbonate, and calcium phosphate. Cuticle is relatively impermeable to water and has a high strength-to-weight ratio, two characteristics important for the successful conquest of the land by the Arthropoda. Ingrowths of the cuticle, called 'apodemes', provide insertion sites for muscles. The cuticle is divided into separate plates, which facilitates movement: the plates are connected by the so-called arthrodial membrane, which comprises thin, flexible, untanned cuticle. Periodic moulting of the cuticle (ecdysis) permits body growth.

exosphere Outer region of the upper atmosphere extending from a base of 500–750 km altitude. The zone has a very low concentration of gases (mostly molecules of oxygen, hydrogen, and helium, although some are ionized). Gases can escape into space, as molecular collisions are much reduced because of the low gas density. The exosphere and much of the underlying ionosphere form part of the magnetosphere.

exotherm *See* poikilotherm.

exotic species Introduced, non-native species.

exotoxin Toxin that is secreted by a living organism.

experimental error Variation between experimental samples. It may be attributed to differences in materials and/or techniques, rather than to real differences (e.g. in growth or behaviour). Experimental error must be monitored in any statistical comparison of experimental data.

exploratory behaviour Form of appetitive behaviour that may be goal-oriented (e.g. the search for food or nesting material) or concerned with the examination of areas or articles with which an animal is unfamiliar, in which case the behaviour often exhibits signs of conflict.

explosive evolution Sudden diversification or adaptive radiation of a group. The term is an old one, rarely used nowadays. Phases of explosive evolution have occurred in all the higher taxonomic groups, i.e. in genera, families, orders, and classes. An example at the ordinal level is the diversification of the mammals at the dawn of the Cenozoic Era.

exponential growth Form of growth in which the logarithms of a value increase linearly in any given period of time. This means that the value grows

more rapidly than it would by linear growth. An example of exponential growth would be a population that grows by 10% of its value in each unit of time. Thus a population that starts with a value of 100 would grow as: 100, 110 (100 + 10% of 100), 121 (110 + 10% of 110), 132.1 (121 + 10% of 121), and so on.

expressivity Degree to which a particular genotype is expressed in the phenotype.

exserted Protruding, e.g. of stamens projecting beyond a corolla, or of a moss capsule projecting beyond the leaves of the gametophyte.

exsiccation Dehydration of an area by a process, e.g. drainage, in the absence of changes in precipitation levels. Draining of marshlands and deforestation are examples of processes that can lead to exsiccation. *See also* desiccation.

exstipulate Without stipules.

extant Applied to a taxon some of whose members are living at the present time. *Compare* extinct.

extinct Applied to a taxon no member of which is living at the present time. *Compare* extant.

extinction 1 The elimination of a taxon. 2 (ethol.) The loss of learned patterns of behaviour from the repertoire of an animal to which they have become irrelevant.

extraformational *See* conglomerate.

extrusion Process involving igneous action at the Earth's surface, in which material is ejected, e.g. via volcanoes. *See* extrusive.

extrusive Applied to all ejected material of volcanic origin. *See also* extrusion.

exuviae *See* detritivore.

exuvium In Arthropoda, the cast exoskeleton left behind after moulting.

eye Organ sensitive to light, developed in many animals. In its simplest form, it consists of a light receptor (ocellus) capable of distinguishing light from shade. In Arthropoda there are compound eyes, each consisting of many separate receptors (ommatidia) each of which contains light-sensitive cells. In Cephalopoda and vertebrates each eye is a single organ, possessing an iris which controls the size of aperture (pupil) through which light passes to a lens, which in turn focuses the light on to a retina.

eyebrow fish (*Psenes arafurensis*) *See* Nomeidae.

eyed lizard *See Lacerta lepida*.

eyed rivulus (*Rivulus ocellatus*) *See* Cyprinodontidae.

'eye' of storm Central part of a tropical cyclone with light winds, generally clear skies, and a slight, horizontal pressure gradient. The diameter of the 'eye' averages 20 km but in a large cyclone can be 40 km or more. The 'eye' of a storm is an area of some air subsidence which produces adiabatic warming.

eyespot Disease of cereals caused by the fungus *Pseudocercosporella herpotrichoides*. Initially a dark smudge appears on the outer leaf-sheath, then an oval 'eye-shaped' lesion develops near the base of the plant, weakening the stem and leading to increasing susceptibility to lodging (i.e. being laid flat by weather).

eyot *See* braided river.

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1929.

F

F Notation, introduced by the geneticist Sewall Wright, for the inbreeding coefficient. *See also* coefficient of inbreeding.

F_1 First filial generation of animals or plants, produced by crossing two parental lines (which are referred to as *P*).

F_2 Second filial generation of animals or plants, produced by selfing or intercrossing of F_1 individuals.

fabric Physical arrangement of particles and minerals in a rock, including its texture and structure, both microscopic and macroscopic.

Fabrosaurus australis Described in 1964 by Ginsburg, *F. australis* is one of the earliest recorded ornithischian dinosaurs. Like other 'bird-hipped' dinosaurs, *Fabrosaurus* possessed a predentary bone at the tip of its lower jaw. Its teeth were small and pointed, and were used to grind plant material. *Fabrosaurus* was a biped with short forelimbs, and a long tail to provide good balance.

facies Sum total of features that reflect the specific environmental conditions under which a given rock was formed or deposited. The features may be lithological, sedimentological, or faunal. A metamorphic facies is an assemblage of metamorphic rocks believed to have been formed under the same or similar temperatures and pressures. In a sedimentary facies, mineral composition, sedimentary structures, and bedding characteristics are all diagnostic of a specific rock or lithofacies.

facilitated diffusion Carrier-mediated membrane transport mechanism, driven by a diffusion gradient.

factor 1 (stat.) One of a pair or series of numbers which when multiplied together yield a given product. **2** (limiting factor) *See* limiting factor. **3** (ecological factor) *See* limiting factor.

factorial number The product of a number and all the positive whole numbers below it. For example, factorial 5 (written as 5!) is $5 \times 4 \times 3 \times 2 \times 1 = 120$.

facultative Applied to organisms that are able to adopt an alternative mode of living. For example, a facultative anaerobe is an aerobic organism that can also grow under anaerobic conditions.

facultative parasite *See* parasitism.

FAD *See* flavin adenine dinucleotide.

Fagaceae Important family of evergreen or deciduous trees in which the leaves are simple, with stipules. The flowers are unisexual, often borne in catkins, and are apetalous, with an inferior ovary. The fruit is a nut, held in a cluster of 1–4 within a cupule. Many of these trees yield valuable timber. There are seven genera, with 900 species, concentrated in the northern hemisphere.

faggot (fagott) Small branch-wood tied into a bundle. Faggots are used mainly for fuel, but also for fencing or thatching.

Fagopyrum esculentum (common buckwheat) *See* Polygonaceae.

fagott *See* faggot.

Fagraea (family Loganiaceae) Genus of trees or shrubs, with a few stranglers or epiphytes, in which the flowers are fragrant, and the corolla white or cream, and up to 30 cm across in a few species. The fruit is a berry seated on the persistent calyx, and has many small seeds. There are 50 species, occurring from Indo-Malaysia to the Pacific islands.

Fagus (beeches; family Fagaceae) Genus of trees, each cupule of whose fruits encloses two oily nuts. The wood is hard, close grained, and valuable. There are 10 species, occurring in northern temperate regions.

fairy-bluebirds *See* Irenidae.

fairy club Common name for the club-shaped fruit body of a fungus belonging to the Clavariaceae.

fairyflies *See* Mymaridae.

fairy ring Circle of dark-green grass (in a lawn or field) in which toadstools may be found. The circle is formed as a result of the radial growth of the fungus through the soil, away from the centre of the ring. Fairy rings are often formed by *Marasmius oreades*.

fairy shrimps *See* Anostraca.

fairy warblers *See* Acanthizidae.

fairy wrens (*Malurus*) *See* Maluridae.

faithful species (fidelity) In phytosociology, a species confined, or nearly so, to a particular association. The species may or may not be constant to the association fidelity, and therefore faithful or characteristic species can be determined satisfactorily only if a full knowledge of other community types is available. Five fidelity classes are commonly distinguished: (a) accidental; (b) indifferent; (c) preferential; (d) selective; (e) exclusive. *See also* companion species; kennarten species; and plant association.

falcate Curved, as a sickle.

Falco (falcons; family Falconidae) Genus of small to medium-sized, mainly rufous, grey, or black raptors, many having dark 'moustaches'. They have long, pointed wings, moderate to long tails, and short, strong feet. They inhabit forest, open country, cultivated land, and cliffs. They are swift fliers, taking mainly avian prey in flight, also

catching small mammals and insects. They nest on ledges, trees, and occasionally buildings, often occupying an old nest. There are 37–39 species, many of them migratory, and found worldwide. Falcons are prized for falconry, especially *Falco peregrinus* (peregrine falcon), which is cosmopolitan.

Falconidae (falcons, caracaras; order Falconiformes) Family of mainly grey or brown, long-winged raptors with long, usually barred tails. Falcons are fast fliers, catching animal prey with their feet; caracaras are long-legged, slow fliers that feed mainly on carrion. They inhabit mainly forest and open country, nesting on the ground, on ledges, or in trees, caracaras building their own nests. There are 10 genera, with about 62 species, found worldwide.

Falconiformes (eagles, falcons, hawks, osprey, secretary bird, vultures; class Aves) Order of diurnal raptors, with sharp claws and strong hooked bills with a basal cere. They have powerful wings, medium to long tails, and are excellent fliers. They are mainly carnivorous, feeding on a wide variety of animal prey. There are five families: Accipitridae, Cathartidae, Falconidae, Pandionidae, and Sagittariidae. They are found worldwide.

falcons 1 *See Falco*; Falconidae; and Falconiformes. 2 (forest falcons) *See Micrastur*. 3 (peregrine falcon, *Falco peregrinus*) *See Falco*.

Fallopian tube In female mammals, the duct connecting the uterus and the peritoneal cavity. The muscular contraction and ciliary action of the tube moves eggs from the ovary to the uterus, and sperms from the uterus to the upper part of the tube, where fertilization occurs.

fallow deer (*Dama*) *See* Cervidae.

false chanterelle Common name for the fruit body of the fungus *Hygrophoropsis aurantiaca*, which is mushroom-shaped, with a convex to funnel-shaped cap, and decurrent gills which are narrow and forked. The whole is bright orange-yellow, or peach-coloured. The spore print is white. *H. aurantiaca* is common throughout the N. hemisphere under conifer trees in late summer and autumn.

false cirrus (anvil cirrus) *See* spissatus.

false death cap Common name for the fruiting body of the fungus *Amanita citrina* (*A. mappa*). *A. citrina* resembles the death cap, *A. phalloides*, but is not poisonous. It is common throughout the N. hemisphere on the ground in woodland in late summer and autumn.

false fruit *See* pseudocarp.

false gharial *See* Crocodylidae.

false legs *See* prolegs.

false moray *See* Xenocongridae.

false morel Common name for the fruit body of the ascomycete *Helvella crispa*, which is poisonous, at least when raw.

false rings *See* tree ring.

false roundhead *See* Pseudoplesiopidae.

false sunbirds (*Neodrepanis*) *See* Philepittidae.

false vampire *See* Megadermatidae.

Famennian *See* Devonian.

fantails *See* Muscicapidae; and *Rhipidura*.

fanworms *See* Sedentaria.

farinose Floury or powdery in appearance or texture.

farmer's lung Condition resembling bronchitis which results from an immunological hypersensitivity to the spores of certain actinomycetes found, for instance, in mouldy hay.

farmyard manure *See* muck.

far-red light Light of about 730 nm, which is involved in phytochrome function.

fasciation Malformation in plants in which shoots tend to be thick and flattened and may occur in masses. Fasciation is sometimes caused by infection with the bacterium *Corynebacterium fascians*.

fasciole *See* Spatangoida.

fat *See* lipid.

father lasher (*Myoxocephalus scorpius*) *See* Cottidae.

fathom Unit of water-depth measurement, originally six feet, equal to 1.83 m.

fatty acid Long-chained, predominantly unbranched, carboxylic acid: it may be saturated or unsaturated. Fatty acids have the general formula $R\text{-}(CH_2)_n\text{-}COOH$, where R represents a hydrocarbon group, e.g. CH_3, or C_2H_5. $n = 1$–16.

fault Approximately plane surface of fracture in a rock body in which some relative horizontal, vertical, or oblique movement has occurred. The three fundamental types are wrench, normal, and reverse faults, classified according to the relative sense of motion of the displaced rock bodies and the angle of the fault-plane.

fault-block mountains Mountains or ranges that result from the upthrow of large fault blocks and that are separated from others by basins or troughs, producing an upland unit bounded by normal or reversed faults. It is classically developed in the Great Basin, Utah, USA, where a typical block is tilted and bounded by a steep fault scarp on one side and a by more gentle dip slope on the other. Usually it is dissected by erosion. *See* basin-and-range province; and horst.

fault-line scarp *See* scarp.

fault scarp *See* scarp.

fauna (adj. faunal, faunistic) The animal life of a region or geological period. *Compare* flora.

faunal *See* fauna.

faunal province *See* faunal region.

faunal region (faunal province, faunal realm, faunal zoogeographic kingdom) Biological division of the Earth's surface (i.e. a large geographical area) containing a fauna more or less peculiar to it. The

degree of distinctiveness varies with the region concerned and reflects partly climate and partly the existence of barriers to migration. The number of regions recognized varies from one authority to another, but a minimum of six are recognized: Australian, Ethiopian, Nearctic, Neotropical, Oriental, and Palaearctic. In defining a region, greatest emphasis is given to mammals.

faunal zone *See* assemblage zone.

faunal zoographic kingdom *See* faunal region.

faunistic *See* fauna.

faunizone *See* assemblage zone.

Faviina (order Madreporaria) Suborder of solitary or colonial corals, which appeared first in the Middle Triassic. They are like the related suborder Fungiina, but lack synapticulae, having well-developed dissepiments and dentate septal margins. The suborder contains 11 families, with 178 genera.

fawns *See* Nymphalidae.

fayalite Mineral which occurs in rapidly cooled, igneous rocks, e.g. pitchstone. It is the iron-rich form of olivine. Its chemical composition is Fe_2SiO_4.

Fe *See* iron.

feather Keratinous outgrowth of the skin of birds, highly modified for the purposes of flight, insulation, and display. Feathers can be divided into distinct types: contour feathers, down feathers, intermediate feathers, filoplumes, powder down, and bristles. They are pigmented, iridescent colours being due to scattered light from specially structured feathers. Worn feathers are annually renewed by moulting.

featherback *See* Notopteridae.

feather grass (*Stipa pennata*) *See Stipa*.

feather-stars *See* Antedonacea; Comasteracea; Comatulida; Crinoidea; Mariametracea; Notocrinacea; Paracomatulacea; and Solanocrinitacea.

fecundity Reproductive capacity of an organism.

feedback loop (feedback mechanism) Control device in a system. Homoeostatic systems have numerous negative-feedback mechanisms which tend to counterbalance positive changes and so maintain stability. For example, denitrifying bacteria counteract the effects of nitrogen-fixing bacteria. Positive feedback reinforces change and in natural systems may result in radical environmental alteration. For example, an exceptionally cool summer in high mid-latitudes of the northern hemisphere may impede the melting of snow, leading to unusually high albedo, which reduces absorption of solar energy, leading to further cooling, etc.

feedback mechanism *See* feedback loop.

feedback regulation Process by which the product of a metabolic pathway influences its own production by controlling the amount and/or activity of one or more enzymes involved in the pathway. Normally this influence is inhibitory.

feefarm System of land tenure by which land is held as the absolute property of the tenant (it is fee simple), subject to the payment of a fixed rent in perpetuity, but requiring the performance of no additional service by the tenant.

fee simple *See* feefarm.

Felidae (cats; order Carnivora, suborder Fissipedia, superfamily Feloidea) Family comprising the extant and extinct cats, which are the most specialized of all carnivorous mammals. The brain is large, with large olfactory centres and cerebral hemispheres which overlap the cerebellum. The jaws are powerful and cannot be rotated (as for chewing). The incisors are in a straight line across the jaws, the canines are long, and the cheek teeth are reduced in number, the carnassials being well developed for shearing. The skeleton is specialized for leaping. There are five digits in the forelimbs, four in the hind limbs, all clawed. The claws are retractile in most species, but not in *Acinonyx jubatus* (cheetah). The gait is digitigrade. The cat family had diverged from the stem family of the Carnivora, the Miacidae, in Eocene times, and cats were more or less modern in appearance by the Oligocene. Until the Pliocene, 'sabretooth' and 'false sabretooth' forms are known, and probably it was from the latter that the present-day cat, with much reduced canines, was derived during the Pliocene. Cats are divided into several genera: *Acinonyx*, *Felis*, *Panthera* (or *Leo*), and *Neofelis* (*N. nebulosa* is the clouded leopard) are generally recognized, but some authorities separate *Leopardus* (ocelot and margay), *Herpailurus* (jaguarundi), *Prionailurus* (leopard-cat and fishing-cat), *Puma* (puma), and others as genera distinct from *Felis* in which they are otherwise included. Felids are terrestrial and/or arboreal, most feeding on higher vertebrates but some on invertebrates, fish, and fruit. They are distributed throughout the world except for some oceanic islands, Australasia, and Madagascar. There is controversy whether *Cryptoprocta* (fossa), of Madagascar, should also be placed in the Felidae; it is customarily assigned to the Viverridae.

Felis (superfamily Feloidea, family Felidae) Genus of felids that is often taken to include all the smaller cats, but is restricted by other authorities to the wild cat (*F. silvestris*) and its relatives, and perhaps the lynxes. The puma (also known as the catamount, cougar, Mexican lion, mountain lion, painter, and panther) is classed by most modern authorities as a distinct genus, *Puma*, although some older classifications include it as *Felis concolor*. The cats are highly successful specialized carnivores, some arboreal (though these species are excluded from *Felis* by many authorities), others terrestrial. They subsist on a variety of foods but feed mainly on higher vertebrates. Most are solitary, but social behaviour and communication is advanced and co-operation is not unknown. They are found in Africa, W. and N. Asia, Europe, and N. America; related species (sometimes placed in this genus) occur in SE Asia and S. America.

Felis concolor *See Felis*; and *Puma*.

fell field Area, within the tundra belt, of frost-shattered stony debris with interstitial fine particles, that supports various plant species in a mixed community. The vegetation is sparse, however, and typically occupies less than half the ground. Frequently fell fields display patterned-ground phenomena, due to freeze–thaw activity in the soil.

Feloidea (order Carnivora, suborder Fissipedia) Superfamily that comprises the families Viverridae (civets and mongooses), Hyaenidae (hyenas), and Felidae (cats). These are the most specialized of all mammalian carnivores, the specialization being most marked in the Felidae. The feloids range from the civets, small animals occupying a position in tropical environments similar to that occupied by the weasels in higher latitudes, to the lions and tigers; they include the hyenas, in which the teeth are sufficiently massive to crush bones, permitting hyenas to subsist partly by scavenging.

felsenmeer *See* blockfield.

femur 1 In tetrapods, the upper bone of the hind limb. 2 In Insecta, the third segment in the leg, which articulates with the trochanter proximally, and with the tibia distally. The femur is the largest and most robust segment of the leg in most adult insects. Movement with respect to the trochanter is usually limited.

fen Area of wet peat, but one that is typically alkaline in reaction, or sometimes neutral or very slightly acidic. In Britain the characteristic fenland area is N. East Anglia, around The Wash. Alkalinity is due to ground water draining from surrounding calcareous rocks. *Compare* bog.

fence month Legal period, which varies from one forest to another, during which deer are fawning and may not be disturbed by humans or by cattle.

fenestrated Perforated with small openings or transparent areas.

fennec (*Fennecus* (or *Vulpes*) *zerda*) *See* Canidae.

fennel *See Foeniculum*.

fen peat *See* peat.

fenugreek (foenugreek) *See Trigonella*.

Ferae (infraclass Eutheria, cohort Ferungulata) Superorder comprising the extinct order Creodonta and the extant order Carnivora, which includes all the terrestrial mammalian carnivores, as well as the seals and sea lions (suborder Pinnipedia).

feral 1 Applied to a wild or undomesticated organism. In particular, the term is applied to wild strains of an otherwise domesticated species or to an organism that has reverted to a wild condition following escape from captivity, etc. Some authors make these distinctions: wild species, subject to natural selection only; domestic species, subject to selection by humans; and feral species, formerly domestic species which are now, as escapees, subject once again to natural selection. 2 (geomorph.) Applied to the intricately dissected landscapes of the lower middle latitudes outside the more arid regions, as in parts of New Zealand, the Coast and Transverse Ranges of California, and Japan. It results from the dominance of surface-water erosion leading to high drainage density.

fermentation Anaerobic respiration, usually referring to the formation of ethanol or lactate from carbohydrate, but in fact including any catabolic processes that produce ATP in the absence of oxygen.

ferrallization Part of the leaching process found in tropical soils, by which large amounts of iron and aluminium oxides accumulate in the B horizon of such soils as krasnozems.

ferricrete *See* duricrust.

ferrodoxin Non-haem iron-protein with a low redox potential, which functions as an electron carrier in both photosynthesis (in prokaryotes and eukaryotes) and nitrogen fixation (in certain prokaryotes).

ferruginous Resembling rust, containing rust, or rust-coloured.

fertility 1 Condition of a soil relative to the amount and availability to plants of elements necessary for plant growth. Soil fertility is affected by physical elements, e.g. supply of moisture and oxygen, as well as by the supply of chemical plant nutrients. *See also* fertilizer. 2 (fecundity, fruitfulness) The number of eggs that develop in a mated female over a specified period. It is usually calculated at the stage when this number is readily observable (i.e. in oviparous animals when eggs are laid, in viviparous animals when young are born, or in seed plants when seeds are borne), although strictly speaking it applies from the time that fertilization occurs. Sometimes the term 'fertility' is applied only to the production of fertilized eggs (ova), while 'fecundity' is used for the production of fruit (in angiosperms) or offspring (in animals), so excluding those embryos which fail to develop.

fertilization Union of two gametes to produce a zygote, which occurs during sexual reproduction. Fertilization involves the fusion of two haploid nuclei (containing genetic material from two distinct individuals (cross-fertilization) or from one individual (self-fertilization). The resulting zygote then develops into a new individual. Some aquatic animals, e.g. echinoderms, achieve fertilization externally, gametes uniting outside the body of the parents. Most other animals, particularly terrestrial species, have internal fertilization, with the union of gametes inside the female.

Ferungulata (class Mammalia, subclass Theria, infraclass Eutheria) Cohort, proposed on palaeontological grounds but regarded by some authorities as artificial, that includes the Carnivora (all of the modern mammalian carnivores), the primitive ungulates (including the elephants and sea cows), the Perissodactyla (tapirs, rhinoceroses, horses, etc.), and the Artiodactyla (pigs, camels, cattle, etc.), which are believed to have arisen from a common population in the Palaeocene. At that time all eutherians were rather undifferentiated and it is supposed that the Ferungulata began to diverge rapidly following their break from the ancestral

stock, so that today the cohort comprises 15 orders whose members are far more diversified than those of other cohorts.

Festuca ovina *See* heavy metal tolerance.

fetch 1 (geomorph.) Length of water surface over which the wind blows in generating waves. Together with wind velocity and duration, this determines wave height. Many features of coastal deposition tend to become orientated normally to the direction of maximum fetch. **2** (meteorol.) Distance over which an airstream has travelled across sea or ocean.

fever flies *See* Bibionidae.

Feyliniidae (order Squamata, suborder Sauria (Lacertilia)) Family of lizards, which resemble limbless skinks, but are not closely related to them. The head is flattened, with tiny eyes under transparent scales, and there is no ear opening. The body is cylindrical. The lizards feed mainly on termites. There are four species in a single genus, *Feylina*, occurring in equatorial Africa and Madagascar.

fibratus From the Latin *fibratus* meaning 'fibrous', a species of separate cloud or cloud veil which has rather curved elements, but without hooks. *See also* cloud classification.

fibre 1 Type of plant cell in which the wall has been thickened to perform a structural role. Typically, fibres are elongated cells and have fewer cavities in the thickenings than do other types of thickened cells—however, neither feature is diagnostic. Such cells can be found in the cortex, phloem, and xylem. Commercially, the term refers to a strand of fibre cells, or to the epidermal cells of cotton or kapok seed pods. Flax and hemp fibres come from the phloem. Sisal is extracted from highly lignified leaf fibres of *Agave*. The name 'fibre' is also given to a fine or narrow root. **2** *See* collagen.

fibril Cloud trail observed in cumulonimbus, where drizzle-sized droplets are large enough for their terminal velocities to allow them to depart from the main cloud body.

fibrin Insoluble protein found in blood clots, which it helps to form. It is formed at the site of a wound from a soluble precursor, fibrinogen, by the action of the enzyme thrombin. *See also* blood clotting.

fibrinogen Soluble blood protein that is acted upon by the enzyme thrombin during blood clotting to give the insoluble protein fibrin. *See also* blood clotting; and blood plasma.

fibroblast Connective tissue cell that manufactures and secretes collagen and that is extensively involved in the process of wound healing.

fibula In tetrapods, the post-axial bone of the lower part of the hind limb.

fibulare The post-axial proximal tarsal bone of the ankle.

Ficedula (flycatchers; family Muscicapidae) Genus of small birds, the males brightly coloured, the females duller, which are found mainly in forests. They nest in tree crevices and holes, some utilizing nest boxes. There are 27 species, many migratory, found in Europe, Africa, Asia, the Philippines, and Indonesia.

Ficus (figs; family Moraceae) Big genus of trees, stranglers, root-climbers, and epiphytes which produce watery latex. The leaves usually have conspicuous stipules enveloping the bud. The flowers are minute, unisexual, and inserted on a concave receptacle forming a closed sphere. They are pollinated by specialized wasps. Many are cauliflorous. The fruits are tiny drupes enclosed in a receptacle. The fig. *F. religiosa* is the pipal-tree or bodh-tree. There are 800 species, most of which are tropical.

Fidelia *See* Fideliidae.

Fideliidae (order Hymenoptera, suborder Apocrita) Small family of desert mining bees. It is the sister group of the Megachilidae: members of the Fideliidae resemble those of the Megachilidae in having an abdominal pollen scopa, but differ from them in having scopae also on the hind legs, and in possessing certain primitive characters: three submarginal cells in the forewing, and pygidial and basitibial plates in the female. The brood cells are unlined. The family has a disjunct distribution, with one genus, *Neofidelia*, found in the southern Atacama Desert, Chile; and two genera, *Fidelia* and *Parafidelia*, in southern Africa. One species of *Fidelia* has recently been found in N. Africa. There are fewer than 20 species in three genera.

fidelity *See* faithful species.

fiducial point 1 Temperature at which the atmospheric-pressure scale of a particular barometer reads correctly. The temperature at which this is so in latitude 45° is called the standard temperature of that barometer. At other temperatures and other latitudes, corrections must be applied. **2** Fixed point (indicated by a pointer) that is the zero of the scale of a Fortin barometer.

field blewit (*Lepista saeva*) *See* blewit.

field capacity Water that remains in soil after excess moisture has drained freely from that soil. Usually it is measured as a percentage of the weight or volume of oven-dry soil.

field cricket *See* Gryllidae.

field layer The herb and small shrub layer of a plant community. *Compare* canopy; ground layer; and shrub layer.

field maple (*Acer campestre*) *See Acer*.

field mouse (*Apodemus sylvaticus*) *See* Muridae.

field mushroom Common name for the fruit body of the fungus *Agaricus campestris*, which resembles the cultivated mushroom. It is edible and highly esteemed, and is common in fields, meadows, lawns, etc. in summer and autumn.

Figitidae (suborder Apocrita, superfamily Cynipoidea) Family of wasps, generally small (3–6 mm long) and shiny black, whose larvae are pupal parasites of Diptera, scale insects, and aphids. One subfamily only parasitizes hemerobioid lacewings. The family is not common.

fig wasps *See* Agaonidae.

filament One of the strands of protein, variously grouped according to diameter (in the range 4–15 nm), found in many types of cell. Their functional significance is incompletely understood, but since they are largely composed of the contractile proteins actin and/or myosin it is presumed that the motility of the cell or its contents forms part of their role.

filariasis *See* elephantiasis; and river blindness.

filbert *See Corylus*.

filefish 1 *See* Balistidae. 2 *See* Monacanthidae.

filibranchiate Applied to a type of gill, common to pelecypods, that is composed of sheets of filaments forming a W-shape.

Filicopsida Subdivision of the Pteridophyta, which comprises all living and extinct ferns. They arose in the Devonian from the Trimerophytina group of psilophytes and made an important contribution to Carboniferous floras. They are the most advanced, numerous, and varied of the pteridophytes. In most cases they have relatively large, much-divided leaves, and are still significant components of many different plant communities around the globe.

filiform Thread-like; long and slender.

filling Term used in synoptic meteorology to describe an increase in pressure at the centre of a depression. *See also* deepening.

filopodium Type of pseudopodium that is extremely slender and tapers to a fine point.

filter route Term introduced by the American palaeontologist G. G. Simpson (1940), to specify a faunal migration route across which the spread of some animals is very likely but across which the spread of others is correspondingly improbable. The route thus filters out part of the fauna, but permits the rest to pass. Deserts and mountain ranges provide examples of filter routes.

fimbriate With the margin bearing a fringe, usually of hairs.

Fimbristyllis (family Cyperaceae) Genus of perennial, rhizomatous herbs, which have solid stems. The basal tuft of leaves is sheathing, and the leaves are linear with a grass-like blade. The small, inconspicuous flowers are usually bisexual and held in spikelets with a single bract. The spikelets form panicles or umbels. The perianth is reduced to scales or bristles. Usually there are three stamens. The ovary is superior, and the fruit a nut. There are about 300 species, found in tropical and subtropical regions of SE Asia and Australia, usually in marshy habitats.

fin Appendage of fish and fish-like aquatic animals used for locomotion, steering, and balancing of the body. The skinfold forming the fin membrane is supported by cartilaginous, horny, or bony fin rays, which can be soft and flexible (soft rays) or hard and inflexible (fin spines). The median unpaired fins of fish include the dorsal fin on the back, the caudal fin or tail-fin, and the anal fin behind the vent or anus. Usually there are also two pairs of lateral fins: the pectoral fins and the pelvic (also called ventral or abdominal) fins.

finches 1 *See* Emberizidae; and Fringillidae. 2 (brambling, *Fringilla montifringilla*) *See Fringilla*. 3 (chaffinches) *See Fringilla*. 4 (brushfinch) *See Atlapetes*. 5 (bullfinches) *See Pyrrhula*. 6 (canaries) *See Serinus*. 7 (cardinals) *See* Cardinalidae. 8 (crossbills) *See Loxia*; and Fringillidae. 9 (goldfinches, greenfinches) *See Carduelis*. 10 (hawfinches) *See Coccothraustes*. 11 (mannikins, munias, waxbills) *See Estrilidae*. 12 (plush-capped finch, *Catamblyrhynchus diadema*) *See* Catamblyrhynchidae. 13 (rosefinches) *See Carpodacus*. 14 (seed-eaters) *See Serinus*.

finfoots *See* Heliornithidae.

finger and toe *See* clubroot.

finite resource (non-renewable resource) Resource that is concentrated or formed at a rate very much slower than its rate of consumption and so, for all practical purposes, is non-renewable. *Compare* renewable resource.

finlet Small, isolated fin formed by a separate spine with its own membrane (e.g. in the stickleback, *Gasterosteus aculeatus*) or without a spine (e.g. in tuna).

fin ray Rod-like supports of the fin membrane, composed of cartilage in lampreys, horny fibres in sharks, and bone in bony fish.

Finschia (family Proteaceae) Genus of trees in which the flowers are borne in showy racemes, and are fragrant. *F. chloroxantha* has edible seeds. There are seven species, occurring in Micronesia, Melanesia, and New Guinea.

fin whale (*Balaenoptera physalus*) *See* Balaenopteridae.

fiord *See* fjord.

fir 1 (Douglas fir) *See Pseudotsuga*. 2 (hemlock fir) *See Tsuga*.

fire-bellied toad *See Bombina bombina*.

fireblight Important disease which affects many trees of the Rosaceae (e.g. apple, pear, and hawthorn). Infected trees have the appearance of having been scorched by fire; the tree may be killed within months. The causal agent is the bacterium *Erwinia amylovora*. The disease occurs in N. America and in many parts of Europe; it is notifiable in Britain.

firebote Fuelwood collected for domestic use. ('Bote' means 'bounty', or 'gift'.)

firebrat *See Lepismodes inquilinus*.

firebug (*Pyrrhocoris apterus*) *See* Pyrrhocoridae.

fire climax (pyroclimax) Climax community for which fire is the dominating control factor, as in the long-leaf pine forests of the USA. Fire is also thought to be an important determining factor, interacting in complex ways with grazing and trampling pressure, in the formation of the major grassland areas, e.g. prairies and savannah. Fire is also a major influence, with grazing, on the development and maintenance of heathland communities.

firefly 1 (*Pyrophorus*) *See* Elateridae. 2 *See* Lampyridae.

fire salamander *See Salamandra salamandra*.

Firmiana (family Sterculiaceae) Genus of plants in which the flowers are vivid; with a long calyx tube and no petals; and five carpels which are united but become free and then dehisce to become papery, leaf-like follicles with one or two marginal seeds. There are 15 species, occurring from E. Africa to Indo-Malaysia.

firn (névé) Snow that has survived a summer melting season. It is an intermediate material in the conversion of snow to glacial ice. Normally it is granular, due to the partial melt.

firn wind (glacier wind) Downhill airflow which develops over a glacier during the day, usually in summer. The greater air density over the glacier than over the surrounding surfaces causes this air to sink.

fish Broadly speaking, any poikilothermic, legless, aquatic vertebrate that possesses a series of gills on each side of the pharynx, a two-chambered heart, no internal nostrils, and at least a median fin as well as a tail-fin. If the Agnatha (lampreys and hagfish) are excluded, the fish (Pisces) would still include the Chondrichthyes (sharks and rays), in which the skeleton is cartilaginous, as well as the Osteichthyes (bony fish). In addition to the criteria mentioned, these two classes also possess well-developed gill arches, a pair of pectoral fins, and a pair of pelvic fins. Some consider, however, that only the bony fish (Osteichthyes) should be classed as real fish.

fish culture Cultivation of marine and freshwater fish in ponds or enclosures. In some cases (e.g. trout, carp, and some aquarium species), fish are hatched from eggs, then grown from the larval stage until they attain marketable size. In other cases, juvenile fish are caught and reared until they reach commercial size (e.g. milkfish, eel, and yellowtail).

fish eagles *See Haliaeetus*.

fish-eating bat (*Noctilio*) *See* Noctilionidae.

fishery The planning and execution of techniques designed to catch fish. Recreational fishery (sport fishing) in recent years almost equals the economic and ecological impact of commercial fishery. Continuing research is required, therefore, to monitor e.g. possible over-fishing, pollution of water, or influence of the environment. In commercial fisheries additional factors, e.g. cost of operating boats and fishing gear, national and international competition, and legal aspects, must be taken into account.

fishflies *See* Corydalidae.

fishing gear Equipment used in catching fish. It may be classified as impaling gear (spear, gaff), maze (fyke, trap), gill net, enclosing net (beach seine, purse seine), and towed net (trawl net).

fish kill Mass mortality of fish caused by algal bloom, lack of oxygen, water pollution, and other natural or man-made sudden changes in the aquatic environment.

fish lice Members of two orders of Copepoda, the Caligoida and Lernaeopodida, which are highly modified ectoparasites of marine and freshwater fish and whales.

fishway Water-filled lock, channel, series of interconnected pools, or other structure by which fish may swim or be carried over obstructions, e.g. weirs or dams across a river or inlet. Absence of fishways in man-made obstructions may eventually cause upstream fish populations to die out.

Fissiculata (class Blastoidea) Order of echinoderms which are characterized by the possession of exposed hydrospire slits. They range in age from Silurian to Permian.

Fissidentales (subclass Bryidae) Order of small to medium-sized mosses in which the leaves occur in two distinct rows or ranks. They are found on soil, rotting wood, etc. *Fissidens bryoides* is the commonest British species, often forming dense colonies on mildly acid soils.

fissility Ability of rock materials to split. The term is applied to shales, flags, slates, and schists.

Fissipedia (superorder Ferae, order Carnivora) Suborder of mammalian carnivores that comprises all the mainly terrestrial forms, grouped in the three superfamilies Miacoidea, Canoidea, and Feloidea.

Fistularia villosa (rough flutemouth) *See* Fistulariidae.

Fistulariidae (flutemouth, cornetfish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Small order of tropical to subtropical, marine fish which have an elongate, scaleless body, a long, tubular snout terminating in a tiny mouth, and a small, forked tail-fin with a central long ray trailing behind it. Some species, e.g. *Fistularia villosa* (rough flutemouth) of the Indo-Pacific region, may grow to a length of 2 m. There are about four species, distributed worldwide.

Fistulina (family Fistulinaceae) Genus of fungi in which the fruit body is bracket-shaped with a more or less pronounced lateral stipe. The hymenium lines densely crowded tubes on the under-side of the fruit body. There are three species, found on wood. *See also* beefsteak fungus.

Fistuliporita (class Rhombifera) Order of echinoderms characterized by the possession of exothecal pores developed across all possible plate sutures; a theca composed of numerous, randomly arranged plates; and no stem. They are restricted to the Ordovician.

fitness (Darwinian fitness) Natural selection has been described as the 'survival of the fittest'. The environment, and the competition or struggle for survival within it, determines which individuals are fittest to survive and propagate their genes in the next generation. *See also* selection.

Fitzroya (family Cupressaceae) Genus consisting of one species, *F. cupressoides*, which is a large, rare, coniferous tree of S. Chile. It is hardy in Britain.

five-banded flagtail *Kuhlia taeniura*. *See* Kuhliidae.

fixation 1 (pedol.) Soil process by which certain nutrient chemicals required by plants are changed

from a soluble and available form into a much less soluble and almost unavailable form. 2 (gen.) (a) First step in making permanent preparations of tissues for microscopic study, by killing cells and preventing subsequent decay with as little distortion of structure as possible. Examples of fixatives are formaldehyde and osmium tetroxide, often used as mixtures. (b) Term applied to gene frequencies when all members of a population are homozygous for a particular allele at a given locus.

fixed-action pattern Apparently stereotyped behaviour, exhibited or capable of being exhibited by all members of a species or higher taxonomic group, which may be used to achieve more than one objective, which may be innate or learned, and whose acquisition may be affected by environmental factors. Examples include the calls of certain birds: these are influenced by sounds heard by the birds early in their lives, but once acquired the songs are performed in a stereotyped way.

fjord (fiord) Long, narrow, deep, U-shaped coastal inlet which usually represents the seaward end of a glaciated valley that has been partially submerged. The water depths often exceed 1000 m except near the mouth where a bar or sill may be present.

flabby whalefish *See* Cetomimidae.

flabelliform Shaped like a fan.

flaccid Wilted. The state of cells when they are short of water.

flacherie Disease of the silkworm (*Bombyx mori*), which is apparently caused by a virus.

Flacourtia (family Flacourtiaceae) Genus of small trees or shrubs in which the twigs are at first spiny. The flowers are unisexual. The fruits are fleshy drupes with several stones: they are edible in some species. There are about 15 species, occurring in Africa, and from Asia to Polynesia.

Flacourtiaceae Family of trees or rarely shrubs, in which the leaves are simple, with small stipules, and the stalk commonly kneed. The flowers are small, regular, unisexual or hermaphrodite, their parts free, the ovary unilocular and usually superior, the ovules parietal. Fruits are various. There are 84 genera, with 1300 species, occurring mainly in the tropics.

flagella 1 Plural of flagellum. 2 *See Calamus*.

Flagellaria (family Flagellariaceae) Genus of giant, slightly woody climbers, with elongate, parallel-nerved tendrillate leaves with sheathing bases. The flowers are hermaphrodite, and petaloid. There are three species, found in the Old World tropics.

Flagellariaceae Small family of monocotyledonous herbs, in which the leaves are elongate, and parallel-nerved. The flowers are regular, with three-plus-three tepals, and six stamens: the ovary is superior and trilocular. The fruit is a fleshy drupe. There are three genera, with seven species, found in the tropics.

flagellum 1 Thread-like organelle which usually functions in locomotion. Flagella are found on some bacteria and on a range of eukaryotic cells, including those of certain fungi, protozoa, and algae. Bacterial and eukaryotic flagella are very different both in structure and mode of operation. Bacterial flagella rotate; eukaryotic flagella undulate. The eukaryotic flagellum has the more complex structure, and there are two types: the whiplash type, which is smooth and whip-like, and the tinsel type, which bears numerous fine, hair-like projections along its length. 2 In certain liverworts, a slender, filamentous, runner-like stem which carries much-reduced leaves. 3 The antennal segments distal to the scape in Hymenoptera (bees, wasps, and ants) which have geniculate (elbowed) antennae. Sometimes the term is also applied to geniculate antennae found in weevils (Curculionoidea).

flagtail *See* Kuhliidae.

flame of the forest (*Delonix regia*) *See Delonix*.

flamingos *See* Ciconiiformes; Phoenicopteridae; and *Phoenicopterus*.

Flammulina (family Tricholomataceae) Genus of fungi which form mushroom-like fruit bodies. The cap is slimy and reddish to orange or yellow; the stipe is central and velvety. *F. velutipes* ('velvet shank') forms clusters of fruit bodies in winter on the trunks and dead wood of broad-leaved trees.

Flandrian The present interglacial. Evidence suggests that the so-called post-glacial period, the warm phase following the last (Devensian) ice advance or cold phase, is more appropriately treated as another interglacial of the Quaternary (or Late Cenozoic) Ice Age. In Europe, the warmest Flandrian stage occurred during Atlantic times, about 6000 BP (the Hypsithermal is the equivalent N. American climatic optimum). No consensus view exists as to when the ice advance or extreme cold conditions will prevail once again in high mid-latitudes, nor as to how quickly these conditions will arise. The Flandrian is sometimes referred to alternatively as the Holocene interglacial.

flannel flowers *See Actinotus*.

flask fungi Fungi which form flask-shaped ascocarps or perithecia.

flathead *See* Platycephalidae.

flat-headed borer *See* Buprestidae.

Flatidae (order Hemiptera, suborder Homoptera) Family of homopterans in which the forewings (tegmina) are broad and brightly coloured, and have a broad costal cell with many transverse veins. Some species occur in two different colour forms, and when adults of these two forms cluster together on a twig they give the effect of a spike of coloured flowers with green bracts. There are about 1000 species occurring mainly in the tropics.

flatworms *See* Platyhelminthes.

flavin adenine dinucleotide (FAD) A coenzyme derivative of the vitamin riboflavin, which participates in dehydrogenation reactions mediated by flavoproteins. It is an important intermediate in oxidative phosphorylation.

flaviviruses Group (genus) of viruses within the Togaviridae. The virion is enveloped and contains single-stranded RNA. Flaviviruses infect a wide range of animals, and include the causal agents of yellow fever and dengue. The virus is transmitted from host to host by mosquitoes or ticks.

flavoprotein Conjugated protein in which the prosthetic group is a flavin nucleotide coenzyme such as flavin adenine dinucleotide (FAD) or riboflavin mononucleotide (FMN); some flavoproteins contain either haem or metal ions in addition. They are widely distributed in cells of all types and serve as electron transport agents.

flax *See Linum*; and fibre.

flea beetle *See* Chrysomelidae.

flehmen Behaviour, probably with a sexual significance, exhibited by felids, goats, and other mammals when examining a scent mark. Having sniffed the mark intensively, the animal raises its head with its mouth partly open and upper lip slightly drawn back, stares fixedly to its front, and breathes slowly. Sniffing followed by flehmen may occur more than once at a single encounter with a scent mark.

flesh flies *See* Sarcophagidae.

Flexibacter (family Cytophagaceae, order Cytophagales) Genus of gliding bacteria which occur as flexible rods or filaments. Usually they are aerobic. Polysaccharides, e.g. cellulose and chitin, are not attacked. There are many species, found in marine or freshwater habitats. One species, *F. columnaris*, is pathogenic for some fish.

flexuous Wavy; bending in a zigzag manner.

flies *See* Diptera.

Flindersia (family Rutaceae) Genus of trees in which the leaves are usually pinnate, and dotted with glands. The fruit is a capsule, the seed winged. The genus is somewhat intermediate to the Meliaceae. Queensland maple is a fine dark timber from the Australian species. There are 22 species, occurring in the Moluccas, New Guinea, New Caledonia, and tropical Australia.

flint (silex) Variety of chert, which occurs commonly as nodules and bands in chalk. It is deposited in the porous, permeable structures of sponge, diatom, and echinoid skeletons and also in burrows.

floating chronology Tree-ring chronology for a particular area that does not overlap with chronologies from living trees in that area, and therefore cannot be dated absolutely.

floccose Having a loose, woolly, or cottony surface.

flocculation Process in which clay and other soil particles adhere to form larger groupings or aggregates. The reverse of this process is known as dispersion.

floccus 1 From the Latin *floccus* meaning 'tuft', a species of cloud with a tufted appearance, the lower parts of which are rather ragged, often with virga. The species is most associated with cirrus, cirrocumulus, and altocumulus. *See also* cloud classification. 2 Filaments or hairs borne in tufts and having a woolly appearance.

flocking Among birds, the formation of a group with a social organization. In some species flocking is accompanied by communal nesting and roosting, in others it occurs only outside the breeding season. About half of all known species of birds exhibit flocking behaviour at some stage in their life cycles.

floodplain The part of a river valley that is made of unconsolidated river-borne sediment, and periodically flooded. It is built up of relatively coarse debris left behind as a stream channel migrates laterally, and of relatively fine sediment deposited when bankfull discharge is exceeded.

flood tide Rising tide such that there is a raising of the water level and a general movement of water landwards. It marks the period of time between low water and the succeeding high water. *Compare* ebb tide.

flora (adj. floral, floristic) All the plant species that make up the vegetation of a given area. The term is also applied to assemblages of fossil plants from a particular geological time, or from a geographical region in a former geological time. Examples of all three types of usage, respectively, are: British flora, Carboniferous flora, and Gondwana flora. *Compare* fauna.

floral *See* flora.

floral province (floral kingdom, floral realm) Major geographical grouping of plants, especially flowering plants, identified on the basis of floristic distinctiveness, particularly with regard to the degree of endemism at family and generic level. Some authorities distinguish between kingdoms or realms, which are accorded the higher status, and provinces, which have lesser status and go to make up the kingdoms.

floret One of the individual small flowers of a clustered inflorescence, e.g. daisy.

Florida current Part of the Gulf Stream: it extends from the southern tip of Florida to Cape Hatteras, N. Carolina. it is a fast-flowing (1–3 m/s), narrow (50–75 km wide), and deep current, still evident at depths of 2000 m where a velocity of up to 10 cm/s has been measured. It is an example of a western boundary current.

florigen Uncharacterized and unisolated substance or mixture of substances that is transported from leaves which have been stimulated with light for a suitable length of time to the apex, where flower production is initiated.

floristic *See* flora.

floristic region Spatial categorization of plants recognized in terms of floristic composition. The term is often used synonomously with floral province, kingdom, or realm, depending on the authority.

florist's aster *See Callistephus*.

flounder (*Platychthys flesus*) *See* Pleuronectidae.

flower In Angiospermae, the structure concerned with sexual reproduction, consisting of the androecium (male organs) and gynoecium (female organs), commonly surrounded by a corolla (petals)

and calyx (sepals). The male and female parts may be in the same flower or in separate flowers. In many plants the term 'flower' is popularly applied to an inflorescence that in fact comprises numerous small flowers (florets) grouped together.

flower flies *See* Syrphidae.

flowers of tan The myxomycete *Fuligo septica*.

flowerpeckers *See* Dicaeidae; and *Dicaeum*.

flowstone *See* dripstone.

flow till (ablation till) *See* ablation; and till.

flu *See* influenza.

flukes *See* Digenea.

fluorescence Kind of luminescence, in which an atom or molecule emits radiation when electrons within it pass back from a higher to their former, lower energy state. The term is restricted to the phenomenon in cases where the interval between absorption and emission is very short (less than 10^{-3} s).

fluorescent-antibody technique Method for detecting the location of a specific antigen in a cell by staining a section of the tissue with antibody (specific to that antigen) that is combined with a fluorochrome (a substance that fluoresces in ultraviolet light). The antigen is located wherever fluorescence is observed.

fluorite (fluorspar, blue john) Mineral, specific gravity 3.2, hardness 4.0, chemical composition CaF_2, whose name is derived from the Latin verb meaning 'to flow', referring to its low melting point. It is widely distributed in mineral veins alone or as a gangue mineral with metallic ores, and in association with quartz, barite, calcite, galena, cassiterite, sphalerite, and many other minerals. It is distinguished by its cubic crystal form, its hardness, and its solubility in sulphuric acid with the evolution of hydrogen sulphide. It is often yellow, green, blue, or purple, but can be colourless, pink, red, or black, and is often colour-banded. It has a white streak and a vitreous lustre. It crystallizes in the cubic system. The crystals are often cubes, and they can also be octahedra and rhombododecahedra, and a mixture of forms. Fluorite is used extensively as a flux in the smelting of iron, in the ceramic industry, and in the chemical industry. The deep-purple, banded variety, 'blue john', is used for ornament and vases.

fluorspar *See* fluorite.

flutemouth 1 (trumpetfish) *See* Aulostomidae. 2 *See* Fistulariidae.

fly See Diptera.

fly agaric *Amanita muscaria*, an agaric which forms bright-red, mushroom-shaped fruit bodies, typically with remnants of the white universal veil adhering to the cap. It produces hallucinogenic poisons. It is common on the ground under birch (*Betula*) or pine (*Pinus*) in autumn.

flycatchers 1 *See Empidonax*; *Ficedula*; *Muscicapa*; and Muscicapidae. 2 (fantails) *See Rhipidura*. 3 (monarchs) *See Monarcha*. 4 (phoebes) *See Sayornis*. 5 (tyrant flycatchers) *See* Tyrannidae.

flying dragon *See Draco volans*.

flying fish *See* Exocoetidae.

flying fox *See* Megachiroptera.

flying frogs *See* Rhacophoridae.

flying gurnard (*Dactylopterus volitans*) *See* Dactylopteridae.

flying lemur (*Cynocephalus*) *See* Cynocephalidae.

flying lizard *See Draco volans*.

flying squirrel (*Petaurista alborufa*) *See* Sciuridae.

flysch Sedimentary facies term used to describe a thick succession of redeposited, deep-sea, clastic material of synorogenic character.

foehn wall *See* föhn wall.

foehn wind *See* föhn wind.

Foeniculum (fennel; family Umbelliferae) Genus of herbs with yellow flowers and finely divided leaves, containing a pungent, aromatic oil used in cooking and for flavouring. There are two or three species, probably native to S. Europe.

foenugreek (fenugreek) *See Trigonella*.

fog Condition of atmospheric obscurity near the ground surface, caused by the suspension of minute water droplets in conditions of near saturation of the air. The formation of fog is aided by any concentration of smoke particles, as these act as condensation nuclei, and may cause fog at levels of humidity below saturation point. Visibility is below 1 km. The cause of condensation of the water droplets may be radiation cooling of the ground, advection of warm air over a cold ocean or cold ground, or conditions at a front. *See also* smog

föhn wall Mass of cap cloud and associated precipitation over windward and parts of leeward slopes on mountain barriers, resulting from the föhn effect. *See also* föhn wind.

föhn wind Generic term for warm, dry winds in the lee of a mountain range. It was originally used in the European Alps. After cooling on the windward ascent at the saturated adiabatic lapse rate of 0.5 °C/100 m, with the resulting condensation and precipitation, the air descending on the leeward side of the mountain range is warmed through compression at the dry adiabatic lapse rate of 1 °C/100 m. This produces a warming wind on the lee side, with higher temperatures than occurred in the same air on the upslope side of the mountains.

fold Structure of buckled or bent, stratified rocks, caused by a process of deformation.

foliation Rock fabric caused by the layered arrangement of minerals. The layers may be plane, wavy, or crumpled; and may be parallel, but not necessarily to bedding or cleavage. Cleavage is a variety of foliation.

folic acid (pteryoglutamic acid) Member of the vitamin-B complex, a deficiency of which results, among other symptoms, in reduced growth and anaemia. Coenzymes derived from folic acid participate in the production of the nitrogenous bases adenine and thymine, which are essential for DNA synthesis.

folicolous Growing on leaves.

Folin–Ciocalteau reaction The basis of a colorimetric method for the quantitative determination of proteins. It is dependent upon the production of a blue colour as a result of the reaction of tyrosine in the sample with a phosphomolybdotungstic-acid reagent.

foliose Leaf-like; made up of thin flat lobes, as are the thalli of certain types of lichen.

follicle 1 Dry fruit derived from a single carpel which dehisces along one side only. 2 *See* Graafian follicle.

follicle-stimulating hormone (FSH) Proteinaceous, gonadotropic hormone secreted by the anterior pituitary (adenohypophysis) that stimulates spermatogenesis in the testis and the growth of follicles in the ovary.

Fomes (family Polyporaceae) Genus of fungi, in which the fruit bodies are often large, perennial, and corky or woody in texture; and have light chestnut-brown 'flesh'. They are found on living or dead trees. Many species formerly belonging to this genus are now classified in other genera: for example, *F. annosus* is now *Heterobasidion annosum* and *F. igniarius* is now *Phellinus igniarius*. *See also* tinder fungus.

Fontinalis (order Isobryales) Genus of mosses, which are usually aquatic. The stems are long and irregularly branched. Leaves are ovate or lanceolate, concave or plane, and nerveless. There are about 20 species, found mainly in northern temperate regions. Two species are found in Britain. *F. antipyretica* grows on wood or rocks in slow-moving rivers and streams, and in lakes and ponds. The shoots are long (up to 70 cm) and little branched; leaves are borne in three ranks, and each leaf is folded and has a sharp keel. *F. squamosa* lacks the keel on the leaves and is found in fast-moving, non-calcareous waters.

food begging Juvenile behaviour that may endure into adulthood (e.g. forming part of some courtship rituals), in which young that are dependent on their parents for food stimulate adults to feed them.

food-chain Transfer of energy from the primary producers (green plants) through a series of organisms that eat and are eaten. At each stage much energy is lost as heat, a fact that usually limits the number of steps (trophic levels) in the chain to four or five. Two basic types of food-chain are recognized: the grazing and detrital pathways. In practice these interact to give a complex food-web.

food-chain efficiency The ratio between the energy value (the nutritional value, discounting indigestible parts such as hair or feathers) of prey consumed by a predator and the energy value of the food eaten by that prey. Maximum food-chain efficiency (gross ecological efficiency) occurs when the yield of prey to the predator is such that the surviving prey just consume all the available food: this implies that the food of the prey is being exploited to the best advantage by the predator.

food poisoning Non-specific term for gastroenteritis caused by the ingestion of food contaminated with pathogenic bacteria or their toxins. There are many possible causal agents; one of the commonest is *Salmonella typhimurium*.

food vacuole (gastriole) Small vesicle that is formed inside a protozoan cell and within which food particles ingested by the cell are contained and subsequently digested.

food-web *See* food-chain.

foolish seedling disease *See* bakanae disease.

fool's gold *See* pyrite.

foot-and-mouth disease (hoof-and-mouth disease, aphthous fever) Extremely contagious disease which affects many types of animal and which is of great economic importance. The form of the disease varies with animal species. In cattle it involves fever and the development of blister-like vesicles in the mouth and nose, and on the udder and hoofs. Sheep, goats, and pigs may show lameness. It is caused by a virus in the Picornaviridae. Disease control is effected by vaccination or by the slaughter of infected animals.

football fish *See* Himantolophidae.

footmen *See* Arctiidae.

foraging All behaviour associated with the searching for, obtaining, and consuming of food.

foramen magnum Opening at the posterior end of the skull through which the spinal cord passes.

Foraminiferida (class Rhizopodea) Order of testate, amoeboid protozoa in which the test is calcareous and consists of one to many chambers. The arrangement of multiple chambers may be linear, spiral, cone-like, etc. Numerous fossil foraminiferans are known, usually less than 1 mm across; though some, like the fusilinids (Carboniferous to Permian) and nummulitids (Eocene to Oligocene) were appreciably larger. Some measured up to 100 mm in diameter. All species live in marine environments. The cell is protected by agglutinated sedimentary particles or by a secreted test (shell). Agglutinated forms predominated in the Cambrian and Ordovician, while the other forms appeared in the Ordovician and diversified greatly in the Devonian. The Foraminiferida are important zonal fossils, and some planktonic varieties can be used for stratigraphic correlation on virtually a worldwide scale.

forb Non-grassy, herbaceous species, typical of grassland communities, e.g. legumes and composites.

forced convection Mechanical turbulence, with the development of eddies, in air flowing over an uneven surface.

forceps Modified insect cerci which are found in the Dermaptera (earwigs), and the family Japygidae (order Diplura). In the earwigs they are used to grasp prey, and in offence and defence. They may also assist in the folding of the membranaceous hindwings beneath the short tegmina, after flight.

Forcipulatida (starfish; class Stelleroidea subclass Asteroidea) Order of starfish characterized by the nature of the skeletal framework that surrounds the

mouth, the mouth angle plates originating as modified ambulacral ossicles. In addition, the pedicellariae are pincer-like (furcipulate).

Fordia (family Leguminosae, subfamily Papilionatae) Genus of small trees in which the leaves are pinnate. The flowers are borne in cauliflorous racemes. There are 13 species, occurring from S. China to the Philippines.

fore reef Talus slope on the seaward side of a reef. This seaward face of a reef is constantly under attack by waves and currents.

foreshore Lower shore zone that lies between the normal high- and low-water marks. The foreshore may either be a plane slope dipping seawards at a low angle, or be marked by the development of longshore bars (ridge-and-runnel topography), depending on the nature of the wave attack.

forest 1 Extensive tract of land that is covered with trees and undergrowth, sometimes intermingled with pasture. Ecologically it is a plant formation comprising trees growing closely together, typically straight-stemmed and upright rather than spreading in form, and with the canopies forming a foliage layer which shades the ground almost completely. 2 A collective noun describing the trees that comprise an area of forested land. 3 In Britain, from Norman times, a district reserved for hunting of deer, often belonging to the sovereign, to which special laws applied and which was administered by special officers. The word 'forest' is derived from the Latin *foris*, 'out of doors': the land lay beyond the lands enclosed for agriculture or parkland, and was unfenced. The land set aside as forest was not necessarily tree-covered, especially in the uplands, and might include open heath, grass, and bog, as well as wooded areas. Most of the land formerly under forest law has been disafforested, although a district may still bear the 'forest' designation, e.g. 'Dartmoor Forest'. Some Crown forests, never disafforested, came to be used for growing timber, especially for shipbuilding, and today are managed by the Forestry Commission, e.g. New Forest, Forest of Dean. 4 To plant with trees. *Compare* woodland.

forester moths *See* Zygaenidae.

forest falcons *See Micrastur*.

forest flies *See* Hippoboscidae.

forest law Body of laws relating to forest land, and primarily concerned with the conservation of deer.

forestry 1 Practice of growing and managing forest trees for commercial timber production. This includes the management of specially planted forests, of native or exotic species, as well as the commercial use of existing forest, and the genetic improvement of timber trees for selected purposes. 2 Scientific study of tree growth and timber-production systems.

Forficula auricularia (European earwig) *See* Forficulidae.

Forficulidae (class Insecta, order Dermaptera) Large, cosmopolitan family of typical earwigs which includes *Forficula auricularia* (European earwig), an occasional pest of vegetable and fruit crops, and of ornamental plants.

forget-me-not *See Myosotis*.

forked lightning Lightning discharge in which luminous branches from the main channel are seen. *See also* sheet lightning.

formation 1 (plant formation) In vegetation description and analysis, a classificatory unit which usually implies a distinctive physiognomy rather than a distinctive species composition. In detail, the various phytosociological traditions ascribe slightly different meaning and hierarchical status to the term. The early European schemes grouped associations into alliances and then formation groups (e.g. schlerophyllous scrub), and then formation classes (e.g. schlerophyllous woodland and scrub). The formation classes are roughly equivalent to the major world biomes. 2 *See* formation type. 3 (geol.) The fundamental unit used in lithostratigraphy. Specific features distinguish one rock formation from another. The thickness of the formation is unimportant in its definition, as a given formation may vary within different outcrops. Formations may be subdivided into members and together several formations constitute a group.

formation type World vegetation type which has a relatively uniform appearance and life-forms. A formation is a geographically distinct component of a formation type. For example, the rain forest is a formation type, the S. American part being one of the four constituent formations. The term 'biome' is nearly synonymous with 'formation type', and 'formations' are also known as 'regions'. A formation type is generally regarded as climatic climax vegetation.

form-genus Non-phylogenetic, artificial taxon of convenience used for the asexual states of certain fungi. Such imperfect fungi are grouped into form-genera on the basis of similarities between asexual reproductive structures or other vegetative characteristics.

Formicariidae (antbirds; order Passeriformes) Family of small to medium-sized black, grey, or brown birds, sometimes streaked or barred. They have short, rounded wings, and short to long tails; their legs are short (arboreal) to long (terrestrial); and their bill is strong and slightly to very hooked. They inhabit forest and scrub, where they are arboreal or terrestrial, building nests in treeholes, hanging from branches, or on the ground. They are insectivorous, often feeding on and associating with ants. There are 53 genera, with about 229 species, found in C. and S. America.

Formica rufa (wood ant; order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Formicinae) Species of large, red ants, which inhabit huge mound nests, built from pine needles and other vegetation in northern temperate forests. They are active hunters with good vision, and frequently tend Homoptera on trees.

Formicidae (Formicoidea, ants; order Hymenoptera, suborder Apocrita) Family of insects in

which the petiole is composed of one or two narrow segments. All the known species are social. Colony activities are co-ordinated by pheromones and trophyllaxis. Males and female are usually alate. After the nuptial flight, inseminated females shed their wings and found colonies by laying eggs and rearing larvae, often using the reserves in the now useless wing muscles. The female worker caste is always wingless, usually sterile, and often shows polyethism. Some species are dulotic. Most species are scavengers of animal remains; others are seed eaters, active predators, or fungus feeders. Many species obtain honeydew from Homoptera. Nest sites range from cavities in wood or soil to carton or leaf constructions. Some species are symbiotic with plants. About 8000 species have been described, but the total number is probably around 13 000 species.

Formicinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of ants which have a single petiolar segment. The tip of the gaster is armed with an acidopore (a flexible, hair-fringed nozzle), through which venom containing formic acid is ejected. There are about 5000 species, with a worldwide distribution. *See also Oecophylla*.

Formicoidea *See* Formicidae.

formula of vegetation Shorthand system for the rapid, precise description of vegetation. For example, in Christian and Perry's (1953) scheme, A, B, and C respectively denote trees, shrubs, and herbs; 3, 2, and 1 indicate size as tall, medium, and short; density is recorded as x, y, and z, indicating respectively dense, average, and sparse. Average layer heights are also appended. There are many other such schemes, of varying complexity.

Fortin barometer Mercury barometer that requires the accurate setting of the mercury level at a fixed point (scale zero). The reading of the mercury height is then taken by adjusting a vernier scale to the top of the mercury column. *See also* Kew barometer.

Fortunella (family Rutaceae) Genus of small trees in which the leaves have a winged petiole. The fruit resembles an orange. Several are cultivated as cumquats. There are six species, occurring from E. Asia to Malaya.

fossil The remains of a once-living organism, generally those that lived prior to the last glacial period, i.e fossils are older than 10 000 years. They include skeletons, tracks, impressions, trails, borings, and casts. Fossils are usually found in hard rock, but not always: for example, woolly mammoths living 20 000 years ago were recovered from the frozen tundra of Siberia.

fossorial Burrowing.

fosterite Mineral which occurs in association with metamorphosed, dolomitic limestone. It is a magnesium-rich form of olivine with a specific gravity of 3.2. Its chemical composition is Mg_2SiO_4.

foulbrood Fatal disease of the larvae of honeybees (*Apis mellifera*); the causal agent may be either *Bacillus larvae* or *Streptococcus pluton*.

founder effect A new population (e.g. on an oceanic island) may be derived from a single individual or a limited number of immigrants. This is the founder effect. The founder or founders will represent a very small sample of the genetic pool to which it or they formerly belonged. Natural selection operating on this more restricted genetic variety soon yields gene combinations quite different from those found in the ancestral population.

foureye butterfly fish (*Chaetodon capistratus*) *See* Chaetodontidae.

four-eyed fish *See* Anablepidae.

four-lined snake *See Elaphe quatuorlineata*.

four-o'clock plant (*Mirabilis jalapa*) *See* partial dominance.

four-winged sophora (*Sophora tetraptera*) *See Sophora*.

foveate Marked with small depressions or pits.

fowl cholera Acute, infectious, often fatal disease of fowl caused by the bacterium *Pasteurella multocida*.

fowl pest Disease of birds, which may be either fowl plague or Newcastle disease.

fowl plague Disease of birds (including fowl, ducks, and turkeys) which is of considerable commercial importance. Wild birds, particularly water fowl, are naturally infected but do not normally show symptoms. In domestic fowl the disease affects the respiratory tract, but the central nervous system may also be involved. The disease is caused by an avian influenza virus.

fox (*Alopex*, *Cerdocyon*, *Dusicyon*, *Vulpes*) *See* Canidae.

fox-fire Light (bioluminescence) emitted by moist decaying wood or by certain types of fungal fruit body.

foxglove *See Digitalis*.

fractional crystallization Evolutionary process by which magma may change composition through the crystallization and removal of minerals.

fracto- *See* fractus.

fracture General term applied to any break in a material, but commonly applied to more or less clean breaks in rocks or minerals that are not due to cleavage or foliation.

fractus (fracto-) From the Latin *fractus* meaning 'broken', a species of cloud that has an irregular or ragged form. The term is applied to cumulus and stratus. *See also* cloud classification.

Fragaria (strawberry; family Rosaceae) Genus of perennial, stoloniferous herbs in which the leaves are borne in basal rosettes, each leaf with three toothed leaflets. The flowers have a pentamerous epicalyx. The receptacle becomes enlarged, juicy, and brightly coloured in the fruit, with the tiny achenes on its surface. It is much cultivated for its delicious fruits. There are about 35 species, found in northern temperate and tropical regions, and in S. America.

fragipan Subsoil horizon, found deep in a soil profile and having a high bulk density. It is a dense, brittle, and compact layer, apparently with little or no cementation horizon, associated with acid soil conditions.

Francisella Genus of bacteria not assigned to a taxonomic family. The cells are very small, ovoid to variable in shape, Gram-negative, and non-motile. They are chemo-organotrophic, and can grow only in the presence of air. They are found in aquatic environments and as parasites of animals, including humans. Some strains can cause disease in humans.

francolins *See Francolinus*.

Francolinus (francolins; family Phasianidae) Genus of medium-sized, mainly brown gamebirds, some with black, white, and chestnut markings. They have large bills and the legs of males have one or more spurs. They inhabit forests, scrub, and grassland, feeding on vegetable matter and insects, and nesting on the ground. There are 40 species, found in Europe, Africa, and Asia.

frangipani (pagoda tree, temple tree; *Plumeria oubra*) *See Plumeria*.

Frangula alnus (alder buckthorn) *See* Rhamnaceae.

Frankeniaceae (sea-heaths) Family of low shrubs or herbs with narrow, often heath-like leaves in opposite pairs without stipules. The flowers are small, regular, and tetra-, penta-, or hexamerous. There are four genera, with about 60 species, found mainly in saline areas of temperate and subtropical regions.

Frankiaceae (order Actinomycetales) Family of mycelium-forming bacteria, containing one genus, *Frankia*, with several species. It is found in root-nodules in a variety of non-leguminous, dicotyledonous plants. The root nodules can bring about the fixation of atmospheric nitrogen. *F. alni* occurs in coralloid nodules on the roots of alder (*Alnus*). Nodules are generally present only near the soil surface.

Fraser Darling effect Acceleration and synchronization of the breeding cycle that results from the visual and auditory stimulation experienced by individual members of large breeding colonies of birds. It tends to shorten the breeding season and to present predators with a sudden flush of eggs and young, thus increasing the likelihood that any given pair of adults will breed successfully. Named after Sir Frank Fraser Darling, who proposed the existence of the effect in 1938.

Frasnian Stage of the Devonian Period noted for the culmination of the first major radiation of the single-celled foraminiferids. The stage is the penultimate of seven. Three important groups of goniatites, the prolecanitids, goniatitids, and clymeniids arose during this stage.

frass The fine powdery material to which phytophagous insects reduce plant parts.

Fratercula (puffins; family Alcidae) Genus of large-headed, short-necked, black and white auks, which have distinctive yellow and red, large, laterally compressed bills during the breeding season. The horny bill plates and a horn-like structure around the eye are both shed in winter. Their feet are red with claws modified for digging burrows. They inhabit grassy island slopes and cliffs, breeding in rock crevices and burrows, and spending the rest of the year at sea. They feed on fish and other small marine animals. There are two species, found in the N. Atlantic, N. Pacific, and Arctic oceans.

fratricide The killing of siblings.

Fraxinus (ashes; family Oleaceae) Genus of trees in which the leaves are opposite, and pinnate. The flowers are borne in racemes, are reduced, and are mostly wind-pollinated. The fruit is a samara. The wood is elastic and useful. There are 70 species, found in the northern hemisphere.

frazil ice Flowing water ice that forms platelets rather than continuous sheets; often observed in Canadian rivers. The name is derived from the French *fraisil*, meaning cinder.

free atmosphere The atmosphere above the level to which the effect of friction reaches (commonly taken as about 500 m).

free-living 1 Living independently, i.e. not parasitic on, or symbiotic with, any other organism. 2 Not attached to a substrate.

free-martin *See* intersex.

free-tailed bat *See* Molossidae.

Fregata (frigatebirds; family Fregatidae) Genus of large, long-winged, slender-bodied, mainly black seabirds with long, deeply forked tails. They have long, slender, hooked bills, small feet with partial webbing, and strong claws, the middle one pectinate. Breeding males have a large, inflatable, bright-red throat pouch. They are good fliers, feeding on fish and other marine animals taken from other birds or from the surface of the sea. Their plumage is not waterproof and they do not land on water; they alight rarely on land, on which they walk clumsily. They roost and build their nests in bushes. There are five species, found in the tropical regions of the Pacific, Indian, and Atlantic oceans.

Fregatidae (frigatebirds; order Pelecaniformes) Monotypic family, comprising one genus, *Fregata*.

frenulum Spine or hair found on the hindwing of an insect: it engages a hook to bring about the coupling of the fore- and hindwings. *See also* retinaculum; and wing coupling.

fresh water Water containing little or no chlorine. According to the Venice system, which classifies brackish waters by their percentage chlorine content, fresh water contains 0.03% or less of chlorine. *Compare* brackish.

freshwater butterflyfish (*Pantodon buchholzi*) *See* Pantodontidae.

freshwater fish Fish that live only in fresh water. Many families and orders of fish are considered to include only primary freshwater species, i.e. species that evolved without contact with a marine

environment. Some families have a worldwide distribution, e.g. the Cyprinidae are found in freshwater basins all over the world, except for S. America and the Australian region. Others, e.g. the Cobitidae (loaches), are found only in the Eurasian region. A few families have a very restricted distribution, e.g. the Amiidae (bowfin) are found only in the eastern half of the USA.

freshwater mullet (*Myxus* (*Trachystoma*) *petardi*) *See* Mugilidae.

freshwater turtles *See* Emydidae.

Freycinetia (family Pandanaceae) Genus of plants, nearly all of which are bole-climbers. The leaves are strap-like, with spiny margins. The plants are dioecious. The inflorescences often have showy bracts, purportedly bird- or bat-pollinated. The fruits are fleshy berries, in spherical or cylindrical heads. There are about 100 species, occurring in warm temperate and tropical forests, from Sri Lanka eastward to the Pacific islands.

friable Applied to the consistency or handling properties of soil, meaning that the soil crumbles easily.

friarbird *See Philemon*.

frigatebirds *See Fregata*; and Pelecaniformes.

fright substance *See* alarm substance.

frigid *See* pergelic.

frilled lizard *See Chlamydosaurus kingii*.

frilled shark (*Chlamydoselachus anguineus*) *See* Chlamydoselachidae.

fringed waterlily (*Nymphoidea*) *See* Menyanthaceae.

Fringilla (chaffinches, brambling; family Fringillidae) Genus of finches with peaked heads, white wing markings, and fairly long forked tails. They differ from other members of the family in having no crop. They are found in forests and near habitation, feeding on seeds and insects, building an open cup nest in trees. There are three species found in Europe, Africa, and Asia. *F. montifringilla* (brambling) is highly migratory.

Fringilla montifringilla (brambling) *See Fringilla*.

Fringillidae (finches, grosbeaks; order Passeriformes) Family of small to medium-sized birds with large conical bills, *Loxia* species (crossbills) having crossed mandibles. They have rounded to pointed wings with nine primaries, short to long tails, and medium-length legs. They are found in forests, scrub, and open country, where they feed on seeds, buds, and insects, and build open nests in trees, bushes, or on the ground. There are 18 genera, with 122 species, many migratory, found in Europe, Asia, Africa, and N., C., and S. America. Cardinalidae and part of Emberizidae are often placed in this family.

fringing forest Fringing or gallery forest which often extends along river banks from the rainforest belt into adjacent savannah. The ribbon-like tracts generally resemble the rain forest, but the luxuriance typical of the latter is normally less well developed.

fringing reef *See* reef.

frit flies *See* Chloropidae.

fritillaries *See* Nymphalidae.

frogs 1 *See* Anurans; Ascaphidae; Atelopodidae; Centrolenidae; Leiopelmatidae; Leptodactylidae; Microhylidae; Phrynomeridae; Pseudidae; and Rhacophoridae. 2 (horned frogs) *See* Pelobatidae. 3 (tree frogs) *See* Hylidae. 4 ('true' frogs) *See* Ranidae.

frog-bit (*Hydrocharis*) *See* Hydrocharitaceae.

frogfish (anglerfish) *See* Antennariidae.

froghopper *See* Cercopidae.

frogmouths *See Batrachostomus*; Caprimulgiformes; and Podargidae.

frond Big compound leaf, applied to those of palms and ferns.

frons *See* clypeus.

front Boundary or boundary region separating air masses of different origins and characteristics. Temperature gradients in any horizontal surface are large through the front. Different types of front are distinguished according to the nature of the air masses separated by the front, the direction of the front's advance, and the stage of development of the front. The term was first devised during World War I by the Norwegian school of meteorologists (headed by V. Bjerknes). *See also* anafront; cold front; warm front, katafront; occluded front; and polar front.

frontal bone One of the pair of bones that covers the anterior part of the brain; in mammals it includes air cavities (frontal sinuses) linked to the nasal cavity.

frontal wave Wave-like deformation of the line of a front between two air masses. The wave develops from the northward incursion of warm air and usually travels along the front, with colder air ahead and to the rear. Typically, frontal waves occur in sequences, or 'families', of several waves, and develop into depressions or storm centres travelling more or less eastward as 'secondaries' along the extended cold front to the rear of the original low. The secondaries tend to catch up and merge with the original depression as it slows up in its fully-developed stage.

frontal zone Transition zone, sometimes amounting to a discontinuity, that separates adjacent air masses. Some turbulent mixing takes place. The sloping zone separating a cold wedge under warm air is typically about 1 km in vertical extent and extends about 100 km horizontally.

frontogenesis Development and intensification of frontal boundaries between adjacent air masses.

frontolysis Processes of dissolution or dissipation of a front. Frontal decay results when different air masses stagnate together, or move together or in succession along the same track at the same speed, or incorporate air of the same temperature.

frost Condition in which the prevailing temperature is below the freezing point (0 °C). This may lead to

a deposit of ice crystals on objects, e.g. grass or trees. Such deposits result from condensation when the dew-point temperature is below freezing. *See also* black ice.

frost boil *See* involution.

frost heaving Upward movement of the ground surface or of individual particles, due to the formation of ice in the regolith. It reaches its maximum in silt-dominated material, in which the greatest volume of ice may develop (more than 68% ice by volume). Surface stones may be heaved by the development of needle-ice columns ('pipkrakes').

frost hollow Area (e.g. a valley bottom or a smaller hollow) that is very liable to severe and frequent frosts as a result of dense, cold air moving downslope (katabatic flow) and collecting there under conditions of radiation cooling (e.g. at night).

frost smoke *See* arctic sea smoke.

frost wedging (gelifraction) Fracturing of rock by the expansionary pressure associated with the freezing of water in planes of weakness or in pore spaces.

fructification Process of forming a fruit body, or the fruit body itself.

fructose (D-fructose, levulose, $C_6H_{12}O_6$) A sugar that occurs abundantly in nature as the free form; but also, with glucose, in the form of the disaccharide sucrose.

frugivore Organism that feeds on fruit.

fruit Strictly, the ripened ovary of a plant and its contents. More loosely, the term is extended to the ripened ovary and seeds together with any structure with which they are combined, e.g. the apple (a pome) in which the true fruit (core) is surrounded by flesh derived from the floral receptacle.

fruit bat *See* Megachiroptera.

fruit body (fruiting body) Differentiated, spore-bearing structure, particularly the ascocarps and basidiocarps of ascomycetes and basidiomycetes.

fruit doves *See Ptilinopus*.

fruitflies *See* Drosophilidae.

fruit moths *See* Tortricidae.

Frullania (order Jungermanniales) Genus of leafy liverworts, which have a characteristic type of leaf. Each leaf consists of two parts, the smaller of which is pitcher-like; these tiny pitchers hold water and often contain a characteristic microscopic fauna, including rotifers, which may in some way aid in the nutrition of the liverwort. The thallus is often dark green to copper-brown or purplish in colour. *F. dilatata* and *F. tamarisci* are both common British species; *F. tamarisci* grows on rocks, on the ground, or less frequently on trees, while *F. dilatata* generally grows on trees.

frustration Motivational state which results when the consequences of behaviour are less satisfying than previous experience had led an animal to expect. Often it leads to more determined attempts to obtain satisfaction, but may lead to irrelevant behaviour.

frustule Silica wall of a diatom. *See* Bacillariophyceae.

fruticose Shrubby in habit, as in the thalli of certain lichens (e.g. *Usnea* species).

FSH *See* follicle-stimulating hormone.

Fucaceae (order Fucales) Family of brown seaweeds in which the thallus is typically branched dichotomously and in one plane. There are several genera, including *Fucus*.

Fucales (class Phaeophyceae) Order of brown seaweeds in which the gametes are the only representatives of the haploid generation; gametes are formed in special cavities called conceptacles which are frequently contained in the inflated tips of thallus branches. There are several families, distributed worldwide.

Fuchsia (family Onagraceae) Genus of shrubs or small trees with showy, drooping flowers, each with four, usually spreading, red sepals, and four, usually erect, petals. They are much cultivated, but are frost-sensitive outdoors in N. Europe. There are about 100 species, centred on S. America and New Zealand.

Fucus (family Fucaceae) Genus of seaweeds, species of which occur in abundance on shores in the northern hemisphere. The branches of the thallus are flattened and have a pronounced thickened midrib. Gametes are formed in conceptacles carried in swollen receptacles at the tips of branches. They are found, often abundantly, in the intertidal zone, attached to rocks etc. *See also* bladder wrack; serrated wrack; and spiral wrack.

fugacious Short-lived; soon disappearing.

fugitive species (opportunist species) Species typical of unstable or periodically extreme environments, e.g. deserts or ephemeral ponds, and characterized by a strong dispersal ability. Such organisms are typically smaller than equilibrium species and have shorter life cycles. Hence initially they can colonize an area rapidly during a favourable period, though in the longer term they may lose out in competition with equilibrium species.

Fulgoridae (lantern flies; order Hemiptera, suborder Homoptera) Family of homopterans many of which are large and brightly coloured. In a number of genera the front of the head is produced into a hollow horn which was once believed erroneously to be luminous in some species, giving rise to the common name for the group. There are a few hundred species, most of which occur in the tropics.

Fulica (coots; family Rallidae) Genus of large, stout, dark-grey rails with lobed feet and a yellow, red, or white shield on their forehead, replaced by a muscular wattle in *F. cornuta* (horned coot). They are found in lakes and marshes and are expert divers, feeding on plant and animal matter. They build a nest of vegetation, *F. cornuta* building a mound of stones as a foundation. There are nine species found in Europe, Africa, Asia, Australia, and N., C., and S. America.

Fulica cornuta (horned coot) *See Fulica*.

fuliginous Sooty-coloured; dusky.

fulmars *See Fulmarus*; and Procellariidae.

Fulmarus (fulmars; family Procellariidae) Genus of medium-sized, stout, grey and white petrels with thick necks, robust bills, long nasal tubes, and rounded tails. They are strong fliers with stiff, rapid wing-beats, feeding on fish and offal, often following ships. They breed mainly on cliff ledges and are pelagic and gregarious outside of the breeding season. They are found in the N. Atlantic, N. Pacific, and southern oceans.

fulvettas *See Alcippe*.

fulvic acid Mixture of uncoloured organic acids that remains soluble in weak acid, alcohol, or water after its extraction from soil.

fulvous Reddish-brown or reddish-yellow in colour; tawny-coloured.

Fumariaceae Family of brittle-stemmed herbs yielding a watery juice, and with much cut, alternate leaves. The flowers are borne in racemes, are usually two-lipped with two small sepals and four petals, of which one or two are spurred. Several genera, e.g. *Dicentra*, are cultivated for their flowers. There are 16 genera, with 400 species, found in northern temperate regions and in S. Africa.

fumaric acid Dicarboxylic acid that is an important intermediate in the citric-acid cycle.

fumarole Vent in a volcanically active area, usually of volcanic origin, that is emitting steam, gas, or other volatile constituents at high temperatures (from 200 °C to 1000 °C). It usually represents a late stage of volcanic activity.

Funaria (order Funariales) Genus of mosses in which the leaves are often crowded towards the tops of short stems. The leaves are tongue-shaped to ovate. The capsule is pyriform. It is a cosmopolitan genus of about 250 species. *F. hygrometrica* is commonly taken as a 'typical moss' in elementary bryology studies. The shoots are yellowish-green to green and often occur in extensive green carpets. The capsules are often numerous and are initially green and pear-shaped, becoming yellowish to orange-brown when ripe; they are borne on long, usually curved setae. The species is found on bare soil (in fields, on heaths and moors, in woodland, etc.), particularly on sites of previous fires.

Funariales (subclass Bryidae) Order of acrocarpous mosses which are usually small. The leaves are ovoid or lance-shaped and have a thin nerve. The calyptra are large. There are many genera, including *Funaria*, *Physcomitrium*, and *Splachnum*. They are found mainly on soil.

Fundulus heteroclitus (killifish) *See* Cyprinodontidae.

Fungi One of the three multicellular kingdoms, along with the Metaphyta (plants) and Metazoa (animals). Although resembling plants, Fungi feed by ingesting organic matter, whereas plants are autotrophic and require only inorganic substances as nutrients. As fungi generally lack hard parts they are rarely found as fossils, but thread-like representatives have been found in Precambrian rocks. They probably left the sea about 400 million years ago, when the first plants colonized the land. *See also* fungus.

fungicide Chemical or biological agent that inhibits fungal growth.

fungicole Organism that grows on fungi.

Fungi Imperfecti *See* Deuteromycotina.

Fungiina (order Madreporaria) Suborder of solitary or compound corals, with corallites larger than 2 mm in diameter, which first appeared in the Middle Triassic. They are characterized by the possession of septa formed from numerous trabeculae, and more than two cycles of tentacles around the mouth, which leads to a ridged stomodeum. The septa are fenestrate and linked by synapticulae. The suborder contains 12 families, with 108 genera.

fungus Type of eukaryotic, non-photosynthetic organism, which obtains nutrients by the absorption of organic compounds from its surroundings, which usually has chitin-containing cell walls, and which may be unicellular, filamentous (mycelial), or plasmodial. It may live saprotrophically, symbiotically, parasitically, etc. Some can cause disease in plants or animals, including humans. Distribution is cosmopolitan. *See also* Fungi.

fungus ant *See* Attini.

fungus beetle *See* Mycetophagidae.

fungus garden 'Garden' made by parasol ants (subfamily Myrmicinae; *see also* Attini), in which the ants cultivate fungi as a source of food.

fungus gnats *See* Mycetophilidae.

funicle *See* ovule.

funnel cloud Cloud produced in a low-pressure vortex in the centre of a spiral storm, e.g. a tornado or waterspout.

funnelling The constraining of an airflow by valleys, leading to higher wind speed, convergence, and uplift. Similar effects occur in the air between an advancing front and the face of a mountain barrier.

funnel-web spiders (order Araneae, suborder Mygalomorphae) Spiders of the families Dipluridae, Mecicobothriidae, and Migidae, which construct funnel-shaped webs and possess three tarsal claws. The chelicerae lack a rastellum. Some species are poisonous to humans, e.g. the Australian *Atrax robustus* (funnel-web spider) can give bites causing severe pain, shivering, muscle cramps, blindness, and paralysis of the breathing muscles. Most species of funnel-web spider occur in Australia.

Funtumia (family Apocynaceae) Genus of small trees, including *F. elastica* which produces Lagos or Iré rubber. There are three species, occurring in tropical Africa.

furbelows Common name for the brown seaweed *Saccorhiza polyschides* (*S. bulbosa*) of the order

Laminariales. Although an annual plant, it is the largest seaweed found in Britain, reaching lengths of 3–5 m. The holdfast is an inflated, bulbous structure with a characteristic knobbly surface; the stipe is flattened, twisted at the base, with broad frilly margins; and the blade is fan-shaped in outline and divided into many broad ribbons. Furbelows grows at the low-water mark and below.

furca *See* furcula.

furcipulate Pincer-like.

furcula (furca) The springing organ of Collembola, which arises from the fourth or fifth abdominal segment. It is bent forwards and beneath the body to engage on a ventral tube or retinaculum, which acts as a catch. When the furcula is released, the energy stored propels the animal upwards and forwards, sometimes in a tumbling fashion.

furfuraceous Scurfy; covered with small, bran-like scales.

Furipteridae (thumbless bats; order Chiroptera, suborder Microchiroptera) Family of bats in which the first digit is much reduced. The nose is simple, with no leaf. The ears are simple, the tragus small but distinct. The eyes are very small. The tail is within the uropatagium but does not reach its edge. There are two genera, *Furipterus* and *Amorphochilus*, each with one species, found in the American tropics.

Furnariidae (ovenbirds; order Passeriformes) Very diverse family of small to medium-sized, brown and rufous birds, some streaked; with a short to long, and straight to curved bill; wings that are short and rounded to long and pointed; a tail that is short and rounded to long and forked; and short to medium legs. Ovenbirds inhabit forests, open country, deserts, seashores, and cliffs, and feed mainly on insects but also on some seeds and crustaceans. They vary from arboreal tree-climbers to terrestrial running species; some build the domed mud nests which give the family its name, some nest in holes in trees or banks, others nest on the ground. There are some 34–53 genera, with about 218 species, found in C. and S. America.

furniture beetle *See* Anobiidae.

furunculosis **1** Disease involving the formation of boils (furuncles). **2** Widespread disease of trout and salmon, caused by the bacterium *Aeromonas salmonicida*.

Fusarium (class Hyphomycetes) Form-genus of fungi, which includes species responsible for some important plant diseases, including wilts in various types of cultivated plant (e.g. banana and flax). Some species have perfect (sexual) states classified in the Ascomycotina.

fuscous Sombre in colour; dark-coloured or black.

fusiform Spindle-shaped; elongated with tapering ends.

Fusobacterium (family Bacteroidaceae) Genus of Gram-negative bacteria in which the cells are rod-shaped and non-motile, or motile with many flagella. They are chemo-organotrophic, and cannot grow in the presence of air. There are many species, found for example in the intestines of humans and other animals. They can be pathogenic, and have been isolated for instance from infected wounds.

fustic (*Chlorophora tinctoria*) *See Chlorophora*.

future-natural *See* natural.

FYM (farmyard manure) *See* muck.

G

gabbro Coarse-grained, basic igneous rock of plutonic origin, consisting largely of calcic plagioclase, pyroxenes, and often of olivine. Gabbros result from the slow crystallization of basaltic magmas and are the coarse-grained equivalent of medium-grained dolerites and fine-grained basalts.

gaboon (*Aucoumea klaineana*) *See Aucoumea*.

gadflies *See* Tabanidae.

Gadidae (cod, haddock; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Family of marine fish found in cold to temperate waters. All members of the cod family have spineless fins. Some species have three dorsal and two anal fins. Typically, the pelvic fins are located far forward, ahead of the pectorals, and include more than five soft fin rays. Usually there is a single barbel on the chin. Several species are of considerable commercial importance. The annual catch of the European *Gadus morrhua* (cod), for example, exceeds two million tonnes, but it was already an important staple product to the Scandinavian Vikings. The omnivorous cod is a prolific species: large (10 kg) females may release some four million eggs. Other important species include *Melanogrammus aeglefinus* (haddock), *Molva molva* (ling), and *Lota lota* (burbot), a freshwater representative. There are about 55 species, occurring in the N. Atlantic and Pacific.

Gadiformes Order of cod-like and predominantly marine fish with elongate, tapering bodies and usually long dorsal and anal fins. All fins are supported by soft rays only. There are two or three dorsal fins, and some species have two anal fins. The pelvic fins, if present, are anterior to the pectoral fins. The order comprises about 10 families, e.g. the Gadidae (cod), Merlucciidae (hake), and Macruridae (whiptail). *See also* Paracanthopterygii.

Gadopsidae (river blackfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family comprising *Gadopsis marmoratus* (river blackfish), which is endemic to SE Australia. A fairly slender fish, it has a long, low dorsal fin, and an anal fin partly enveloped by thick skin. The pectoral fins each consist of a single divided ray, and the tail-fin is rounded. Found in fresh water only, it grows to 60 cm.

Gadopsis marmoratus (river blackfish) *See* Gadopsidae.

Gadus morrhua (cod) *See* demersal fish; and Gadidae.

Gaeumannomyces (family Diaporthaceae) Genus of fungi which form perithecia. *G. graminis* (*Ophiobolus graminis*) is parasitic on the roots of grasses and cereals, and causes 'take-all' disease of cereals.

gafftopsail catfish (*Bagre marinus*) *See* Ariidae.

Gahnia (family Cyperaceae) Genus of coarse, tufted, erect perennials, which are rhizomatous. The plants grow in large clumps. The culms are cylindrical, and up to 1.5 m in height, with dark-brown basal leaf sheaths. The leaves and sheaths are slightly bristly, with inrolled margins. The spikelets are two-flowered with a terminal, bisexual, and fertile flower, and a single male flower. The glumes are yellow-brown, turning darker on maturity. The nut becomes blood-red and is three-sided. There are 40 species, found in swampy habitats in Asia, Australia, and the Pacific.

Gaian hypothesis Hypothesis, formulated by James E. Lovelock and Lynn Margulis, that the presence of living organisms on a planet leads to major modifications of the physical and chemical conditions pertaining on the planet, and that subsequent to the establishment of life the climate and major biogeochemical cycles are mediated by living organisms themselves.

gait Manner of walking.

galactolipid Lipid that contains galactose. These are characteristic and important constituents of plant membranes.

galactose Aldohexose monosaccharide not normally found naturally in the free form, but usually as a unit is a larger molecule, e.g. a di- or polysaccharide.

galactosidase *See* beta-galactosidase.

galactoside *See* beta-galactoside.

Galago (bushbaby) *See* Lorisidae.

Galápagos cormorant (*Nannopterum harrisi*) *See* Phalacrocoracidae.

Galápagos giant tortoise *See Testudo elephantropus*.

Galápagos Islands Group of oceanic islands, about 970 km from the west coast of S. America, which Darwin visited in 1835. He encountered a number of endemic species that were to prove influential in the development of his ideas on evolution.

galaxias *See* Galaxiidae.

Galaxias maculatus (common jollytail) *See* Galaxiidae.

Galaxiidae (galaxias, jollytail; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of mainly freshwater fish with a slender, almost tubular, scaleless body. The single dorsal fin is placed well back, close to the rounded tail-fin, but the ventrals are half-way down the belly. Most galaxids live and reproduce in fresh water, but some species—e.g. *Galaxias maculatus* (common jollytail), 20 cm—migrate to estuaries to spawn. Of the 20 species known, 15 are found only in

Tasmania. The family is distributed only in the cooler waters of the southern hemisphere, including Australia, New Zealand (where *G. maculatus* is the basis of the whitebait fishery), S. America, and the Falkland Islands.

Galbulidae (jacamars; order Piciformes) Family of small to medium-sized birds, with metallic green and rufous or dull brown-black plumage. They have long, thin, pointed bills; short, rounded wings; long tails; and four toes, two directed backwards, except for *Jacamaralcyon tridactyla* (three-toed jacamar). They inhabit forest edges, feed on insects, and nest in burrows dug in a bank. There are five genera with 15–17 species, found in C. and S. America.

Galbulimima *See* Himantandraceae.

gale Wind blowing at more than 30 knots (17 m/s).

Galearia (family Euphorbiaceae) Genus of trees or shrubs whose flowers are borne on long spikes. The fruit is a drupe with a leathery wall and sculptured stone. Sometimes the genus is segregated with the family Pandaceae. There are six species, occurring from Indo-Malaysia to the Solomon Islands.

galena Mineral, specific gravity 7.4–7.6, hardness 2.5, chemical composition PbS, whose name is derived from the Latin for 'lead ore'. It is widely distributed and occurs in sediments, hydrothermal veins, and pegmatites, and as a replacement in limestones and dolomitic rocks. In veins it is associated with sphalerite, pyrite chalcopyrite, barite, quartz, fluorite, and calcite. It is distinguished by its lead-grey colour, metallic lustre, and high specific gravity. It has a lead-grey streak. It crystallizes in the cubic system. The crystals are cubes or octahedra, and often octahedral twins. It is the major ore mineral for lead.

Galeocerda cuvieri (tiger shark) *See* Carcharhinidae.

Galeorhinus galeus (tope) *See* nictitating membrane.

Galerida (larks; family Alaudidae) Genus of medium to large larks with conspicuous upright crests. They inhabit open country, feed on seeds and insects, and nest on the ground. There are five species, occurring in Europe, Africa, and Asia.

Galerina (family Cortinariaceae) Genus of fungi, in which the mushroom-shaped fruit bodies are yellowish, rusty, or brown; and small and slender, with a thin, fragile, central stipe. Species are common in mossy areas in woods, tundra, etc. Their distribution is cosmopolitan.

Galeropygoida (class Echinoidea) Order of irregular echinoids, characterized by the possession of a small, central peristome lacking gill slits; the absence of a lantern or perignathic girdle in adults; numerous, very small tubercles; and the development of an anal sulcus. They are found only in Jurassic rocks.

Galium (family Rubiaceae) Genus of herbs which have whorls of leaves and leaf-like stipules. One of the few temperate and herbaceous genera of the family, and atypical of most. *G. aparine* is goosegrass or cleavers. There are 400 species, occurring in temperate regions.

gall (cecidium) Abnormal growth or swelling in a plant. The formation of a gall may be induced by infection of the plant with bacteria or fungi, or by attack from certain mites, nematodes, or insects. Galls may be formed on roots, stems, or leaves. Some galls (e.g. clubroot and crown gall) are symptoms of disease; others appear to do little harm to their hosts, while some may actually be beneficial to the plant (e.g. nitrogen-fixing root nodules of legumes). Galls are variously structured, ranging from a simple outgrowth to a large and histologically complex structure with up to five distinct tissue layers with nutritive zones. Most gall-forming species are members of the insect family Cynipidae (Hymenoptera), and often have complex, heterogynous life cycles, utilizing different parts of the same host or different hosts, which are generally *Quercus* species. The mechanism of gall initiation and development is little understood, and the study of galls offers an unparalleled opportunity for physiological and ecological research. The gall community supports a large number of parasitoids, hyperparasitoids, and inquilines (species which use the gall but do not kill its occupant). *See* Cynipidae; and Cynipinae.

gallery forest *See* fringing forest.

gall gnat *See* Cecidomyidae.

Galliformes (megapodes, curassows, pheasants, hoatzin; class Aves) Order of small to large, fowl-like birds, with short, stout bills, short, rounded wings, and short legs. They are mainly terrestrial, and most are good runners. Important game birds, many are domesticated and have been introduced worldwide. Many are endangered due to hunting and to habitat destruction. There are six families: Megapodidae, Cracidae, Tetraonidae, Phasianidae, Meleagrididae, and Opisthocomidae. They are found worldwide.

Gallinago (snipe; family Scolopacidae) Genus of long-billed, brown, cryptically plumaged, wading birds, with medium-sized legs. They have a varying number of tail feathers, the outer ones adapted to produce a vibratory sound in display flight. Many are gregarious, inhabiting marshy areas. They feed on invertebrates. There are 15 species, found worldwide, but occurring only as migrants in Australia and S. Asia.

Gallinula (gallinules, moorhens; family Rallidae) Genus of medium-sized, brownish or slate-black birds with round bodies, long legs and toes, and short, red and yellow bills. They inhabit mainly freshwater margins and marshes, and feed on vegetable matter and animals, mainly invertebrates. They are mainly ground-nesting, but occasionally nest in bushes. There are 7–12 species, found worldwide. *G. chloropus* (moorhen, or common gallinule) is found on every continent except Australia and the southern Pacific islands.

Gallinula chloropus (moorhen, common gallinule) *See Gallinula*.

gallinules *See Gallinula*; and Rallidae.

Gallionella Genus of Gram-negative bacteria which is not assigned to any taxonomic family. The cells are ovoid or kidney-shaped and produce fibrous 'stalks' which commonly contain ferric hydroxide. They appear to derive energy from the oxidation of ferrous (to ferric) iron. They are micro-aerophilic, and are found in cool, iron-containing natural waters, and in soil.

gall midge *See* Cecidomyidae.

Gallus (junglefowl; family Phasianidae) Genus of medium-sized, multicoloured game birds with bare, red, wattled faces, the male with a large, fleshy comb on its crown. Neck and back feathers are elongated, and their strong legs have sharp spurs. They inhabit forest and dense scrub, are omnivorous, and nest on the ground. *G. gallus* (red junglefowl) is the wild ancestor of the domestic chicken. There are four species, found in India, SE Asia, and Indonesia.

gall wasp *See* Cynipinae.

galvanotaxis Change in direction of locomotion in a motile organism or cell, made in response to an electrical stimulus.

gambier *See Uncaria*.

gamboge The solidified yellow resin of certain *Garcinia* species, used as a paint pigment. Cambodia, whence it comes, derives its name from this product.

Gambusia affinis (mosquitofish) *See* Poeciliidae.

game cropping Culling or husbanding of game animals for meat and other products, all of them usually for human consumption. Game cropping is often advocated as an ecologically sound method of farming the African savannah and similar environments: it is argued that the wide variety of game animals, with their different food preferences, utilize the primary production more efficiently than cattle, and are generally better adapted to the environment. This gives added reason for conservation of the wild ungulate population. Other social, economic, and political difficulties mean that game cropping is practised less widely than may seem desirable.

gametangium Organ in which gametes develop. Found in fungi, mosses, and ferns. *See also* antheridium.

gamete Specialized haploid cell (sometimes called a sex cell) whose nucleus and often cytoplasm fuses with that of another gamete—from the opposite sex or mating type—in the process of fertilization, thus forming a diploid zygote. In some animals, e.g. mammals, the gametes are differentiated: the male is a motile sperm with reduced cytoplasm, and the female is immobile with a large amount of cytoplasm called the egg or ovum, which develops when stimulated. Usually there are many small male gametes, but only a few or one female gamete.

gametocyst In some Protozoa, a shell-like covering around gametes.

gametocyte Cell that will undergo meiosis to form gametes. A cell giving rise to a male gamete is termed a spermatocyte; a cell giving rise to a female gamete is termed an oocyte.

gametogenesis Formation of gametes from gametocytes.

gametophyte Haploid phase of the life cycle of plants, during which gametes are produced by mitosis. It arises from a haploid spore produced by meiosis from a diploid sporophyte. In lower plants (such as mosses), the gametophyte is the dominant and conspicuous generation.

gamma globulin Specific fraction of serum proteins that includes the immunoglobins.

gamma-ray spectrometry Analytical method used in some branches of chemistry and physics for the measurement of the intensities and energies of gamma radiation. Scintillation or semiconductor radiation detectors, coupled to various types of electronic circuitry, enable a spectrum to be accumulated. This may be used to identify the gamma-emitting radioisotopes, and their energy intensities can be used to determine the corresponding element concentrations.

Gammarus (water 'lice') *See* Amphipoda.

Ganges dolphin (*Platanista*) *See* Platanistoidea.

gangrene **1** Condition in which tissues die due to a restriction in the blood supply. Dry types do not usually allow bacterial infection, but moist types do: gas gangrene results from the infection of a deep wound by various species of *Clostridium*, especially *C. perfringens* (formerly *C. welchii*). **2** Rot of stored potato tubers, caused by fungi of the genus *Phoma*.

ganja (*Cannabis sativa*) *See Cannabis*.

gannets *See* Pelecaniformes; *Sula*; and Sulidae.

Ganoderma (family Ganodermataceae) Genus of fungi which form stipitate or sessile, bracket-like fruit bodies. Spores are brown. About 60 species are known. They are found on dead wood, or as parasites of living trees.

Ganodermataceae (order Aphyllophorales) Family of fungi, which produce spores with a complex wall structure; the spore wall is two-layered, with ornamentations on the inner layer penetrating a colourless outer layer. Fruit bodies are annual or perennial, bracket-like, and corky or woody in texture. There are three genera. They are found on wood, and the family includes important wood-rotting fungi.

ganoid scale Type of fish scale with a rhomboid shape, found in some fossil as well as extant bony fish (e.g. *Polypterus* and *Lepisosteus*). The scale consists of a superficial layer of enamel-like ganoine, a middle layer of dentine, and a basal layer of vascular bony tissue.

Ganua (family Sapotaceae) Genus of trees which yield a heavy timber. The terminal buds are scaly; the leaves often have stipules. There are 17 species, found in rain forests of the Malay archipelago.

gap (geomorph.) Transverse valley that cuts through a ridge. It is termed a water gap when occupied by a stream; otherwise it is a wind gap. It

may be a relic of an early stage in the development of a drainage pattern.

gape In animals, the mouth opening between upper and lower mandibles.

gap junction Communicating junction between cells, which provides a rapid passage for ions and small molecules such that they need not cross the bilipid layer of the opposed membranes. At the junction these membranes are only 2–3 nm apart, and within the intervening space there are arrays of closely packed cylinders, approximately 7 nm in diameter, each of which is pierced by a central channel. These junctions are a particular feature of cells in direct electrical coupling with one another, e.g. nerve and heart muscle cells, and perhaps embryonic cells.

gar *See* Lepisosteidae.

Garcinia (family Guttiferae) Genus of trees, and a very few shrubs, in which the crown is monopodial. The leaf bases enclose the apical bud. The flowers are unisexual on different trees, the male commonly with a distinctive pistillode, the female with a big, conspicuous, varied stigma. The fruit is a berry seated on the usually persistent calyx. Mangosteen is *G. mangostana*. There are 400 species, occurring in the Old World tropics.

Gardenia (family Rubiaceae) Genus of trees and shrubs, in which the flowers are large and fragrant. Several are cultivated as ornamentals. There are 250 species, occurring in the palaeotropics.

garden spider *See Araneus diadema*.

garden tiger moth (*Arctia caja*) *See* Arctiidae.

garfish *See* Belonidae.

garlic *See Allium*; and Liliaceae.

garlic toad *See Pelobates fuscus*.

garnet Widely distributed mineral, specific gravity 3.6–4.3, hardness 6.0–7.5, found in high-grade metamorphic and igneous rocks, and also in beach sands and alluvial placers. It is distinguished by its hardness and crystal form. Its colour is very variable and depends on its chemical composition, but it can vary from shades of deep red-brown to almost black, green, white, yellow, and brown. The lustre is usually vitreous. Its chemical composition can be very variable, but falls into two series: the almandite series $(Mg,Fe,Mn_3)Al_2(SiO_4)_3$; and the andradite series $Ca_3(Al,Fe,Cd_2)(SiO_4)_3$. The crystals are cubic, with the most common form being rhombododecahedra. Fine crystals are used as gemstones, but garnet is more generally used as an abrasive.

GARP *See* Global Atmospheric Research Programme.

garrigue Low-growing, secondary vegetation which is widespread in the Mediterranean basin and is derived from the original mixed forest. The dominant plants are aromatic herbs and prickly dwarf shrubs, with drought-resistant foliage. *See also* Mediterranean scrub.

Garrulax (laughing thrushes; family Timaliidae) Genus of medium to large, brown, black, and multicoloured birds with short wings, longish tails, and stout bills. Weak fliers, they hop rapidly through the dense jungle. They feed on seeds, fruit, and insects, and nest in bushes and small trees. *G. leucolophus* (white-crested laughing thrush) is a popular cage bird. There are 48 species, found in Asia.

Garrulus (jays; family Corvidae) Genus of medium-sized crows, with pinkish-brown or purple plumage, and characteristically blue and black barred wing coverts. They inhabit woodlands, feed on acorns, insects, fruit, and some animal food, and nest in trees, shrubs, and tree cavities. There are three species, found in Europe, N. Africa, and Asia. *G. glandarius* (jay) exists in five distinct forms across its range, while *G. lidthi* (Lidth's jay) is endemic to Japan.

Garrulus glandarius (jay) *See Garrulus*.

Garrulus lidthi (Lidth's jay) *See Garrulus*.

Garrya (family Garryaceae) Genus of evergreen shrubs in which the leaves are opposite. The flowers are unisexual in pendulous catkins, the ovary inferior. The fruit is a berry. Several species are cultivated as winter-flowering ornamentals. The genus is related to the Cornaceae. There are 18 species, occurring in western temperate America and the W. Indies.

Garuga (family Burseraceae) Genus of trees, which have pinnate leaves, and whose fruit is a drupe. There are four species, occurring in regions with seasonal climates from the Himalayas to Melanesia.

GAS *See* general adaptation syndrome.

gas bladder *See* swim bladder.

gas-exchange method Method for measuring primary productivity based on rates of carbon-dioxide uptake and oxygen release, these being the easily monitored gaseous raw material and by-product of photosynthesis. *See also* carbon-dioxide method; and oxygen method.

gas gangrene *See* gangrene.

gas-gland (of fish) Glandular structure found in the wall of the swim bladder of bony fish. Richly supplied with capillary blood vessels, it is capable of secreting gas (mainly oxygen) into the swim bladder, thereby increasing the internal pressure. This helps the fish in downward migration, as it compensates for the increase in external pressure.

gaster In Hymenoptera, the abdomen, with the exception of the first abdominal segment, which has become included in the thorax and is separated from the gaster by a narrow neck (petiole).

Gasteromycetes (subdivision Basidiomycotina) Class of fungi in which the basidia are not septate, and basidiospores are not forcibly discharged from the basidia. Fruit body development is typically angiocarpic. There are nine orders. Most are saprotrophic. They are found on soil, rotting wood, dung, etc.

Gasteropelecidae (hatchetfish; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish which have a

compressed body, rather straight dorsal profile, and a strongly curved belly, terminating in a narrow tail (hence 'hatchetfish'). The large pectoral fins are operated by relatively huge shoulder muscles, with the result that the pectoral fins can move so fast that the fish actually leaves the water and flies over the surface, as a real flying fish. Hobbyists keeping *Gasteropelecus sternicla* (keeled belly), 5 cm, in an aquarium should keep a lid on the tank! There are about nine species, found in S. America.

Gasteropelecus sternicla (keeled belly) *See* Gasteropelecidae.

Gasterophilidae (warble fly, bot fly; class Insecta, order Diptera, suborder Cyclorrapha) Anomalous group of true flies which are sometimes classified under the broad family name Oestridae. Adults are moderate to large, hairy flies, whose mouthparts are reduced and not used to feed. The wings have a cross-vein R-M near the base of the wing, veins M_1 and M_3 are straight with Cu_1 + 1A, and do not reach the wing margin. The larvae are all intestinal parasites of large mammals, e.g. horses, elephants, and rhinoceroses. Eggs are laid on the hair of the host and enter the gut by being swallowed while the animal is grooming or licking. The larvae hook themselves into the gut wall, and when mature are voided with faeces: they then pupate on the ground. *See also* venation.

Gasterosteidae (stickleback; class Osteichthyes, subclass Actinopterygii, order Gasterosteiformes) Small family of marine, brackish, and freshwater fish which tend to have torpedo-shaped bodies, a small mouth, small fins, and a series of separate sharp spines on the back preceding the dorsal fin. The body is scaleless, but may possess rows of scutes (bony plates) at the side. The well known *Gasterosteus aculeatus* (three-spined stickleback) grows to 8 cm and can live in fresh as well as salt water. Gasterosteidae are found in temperate waters of the northern hemisphere.

Gasterosteiformes Order of fish found in both fresh and salt water. The dorsal fin is preceded by several sharp spines, as are the anal and pelvic fins. The pelvic fins are located just behind the pectorals. They have rather elongate bodies with a narrow tail region. The order includes the families Gasterosteidae and Aulorhynchidae.

Gasterosteus aculeatus (three-spined stickleback) *See* Gasterosteidae.

Gasteruptiidae (suborder Apocrita, superfamily Evanioidea) Family of parasitic wasps which are very similar to the Ichneumonidae but have the head set on a slender neck and the abdomen set high above the hind coxae. The adults are thin, black, and 13–20 mm long, with short antennae and ovipositors often as long as the body. The larvae are parasitic on solitary bees and wasps nesting in wood, rotten logs, or in the ground. Adults are fairly common and usually found on flowers.

gastrin Peptide hormone produced by the gastric mucosa that stimulates secretion of gastric juices. Secretion of the hormone is initiated as a result of the taste, smell, and thought of food, as well as by mechanical stimulation following the entry of food into the stomach.

gastriole *See* food vacuole.

gastroenteritis Inflammation of the stomach and intestine, usually with vomiting and diarrhoea. There are various possible causes, e.g. food poisoning.

Gastropoda (gastropods; phylum Mollusca) Class of molluscs, including snails and slugs, which have a true head, an unsegmented body, and a broad, flat foot. They range from the Cambrian to the present. Fossils of coiled gastropod shells are common in marine rocks, especially those of the Cenozoic.

gastropods *See* Gastropoda.

Gastrotheca marsupiatum (marsupial frog; order Anura (Salientia), family Hylidae) Species of S. American tree frogs, the females of which carry the fertilized eggs in a dorsal pouch for over 100 days before releasing the tadpoles into water. Adults are arboreal, and 3 cm long.

Gastrotricha (phylum Aschelminthes) Small class (or phylum in some classifications) of microscopic, pseudocoelomate, aschelminth worms in which an excretory system may be present. Some body areas are ciliated and the cuticle may have bristles. They occur in aquatic environments. Superficially they resemble the rotifers. There are about 150 known species.

gastrozooid In polymorphic colonial Coelenterata, a feeding polyp.

gastrula Stage of embryonic development of an animal, following the blastula stage, at which gastrulation movements occur.

gastrulation Complicated process of cell movements that carry those cells whose descendants will form the future internal organs from their largely superficial position in the blastula to approximately their final positions inside the animal embryo. This process usually occurs at the end of the cleavage period. In many embryos, gastrulation occurs in the two main groups of cells: the endoderm (future gut, etc.) and mesoderm (future muscle, blood, etc.). The ectoderm (future external layer and also future nervous system, which later becomes internal) is also rearranged at this time to its approximate final position.

gas vacuole Small gas-filled vesicle, numbers of which are found in certain aquatic bacteria and cyanobacteria. Their function appears to be that of giving buoyancy to the cells.

Gault Clay Glutinous marine deposit found in SE England and France, containing abundant fossil bivalves, gastropods, ammonites, and vertebrates. It is Lower Cretaceous (Albian) in age.

Gause principle *See* competitive-exclusion principle.

Gavia (divers) *See* Gaviidae.

Gavialidae (gharial, gavial; order Crocodilia) Crocodilian family comprising a single species, *Gavialis gangeticus*, the Indian gharial (gavial),

which is found in the Ganges, Indus, and Brahmaputra river systems. It is a fish-eater, with an elongate, narrow snout widening at the nostrils. Its teeth are all similar in shape and size.

Gaviidae (divers; order Gaviiformes) Family of diving birds, brown and black above and white below, with characteristic neck patterns. They are long-necked, with long, pointed bills, and short legs positioned at the rear of the body (which facilitates diving). They are very clumsy on land. They breed on inland lakes, wintering along sea coasts, feed mainly on fish and aquatic invertebrates, and nest on the ground. There is one genus, *Gavia*, and four species, which are migratory, and found in the N. Holarctic.

Gaviiformes (divers; class Aves) Order comprising a single family, Gaviidae.

gazelle (*Gazella*, *Procapra*) *See* Bovidae.

GDP (guanosine diphosphate) *See* guanosine phosphate.

Geastrum (order Lycoperdales) Genus of terrestrial fungi in which fruit-body development begins underground or at the soil surface. The exoperidium splits open from the top and the sections open outwards in a star-like arrangement. The endoperidium contains the spores, which are released via a pore in the tip. *See also* earth star.

Gecarcinidae (land crabs; subclass Malacostraca, order Decapoda) Family of omnivorous land crabs, which spend most of their lives on land, returning to the ocean to breed. They can survive in brackish or fresh water, and are very tolerant of high levels of nitrogenous wastes within their bodies. They occur in tropical America, W. Africa, and the Indo-Pacific region.

gecko *See* Gekkonidae; and Pygopodidae.

Gedinnian *See* Devonian.

geese 1 *See Anatidae*; *Anser*; and *Branta*. 2 (magpie geese) *See Anseranas*.

Geijera (family Rutaceae) Genus of trees and shrubs with simple, alternate, often pendulous leaves, which are glandular. The flowers are held in terminal panicles and are small, and creamy-yellow in colour. The five sepals are united at the base, the five petals star-like or cup-shaped, and the five stamens are spreading. The fruit is a carpel with five seeds. *G. parviflora* (wilga) is often cultivated. It is a small, bushy tree with long, narrow, linear, greenish-grey leaves. There are seven species, found in SE Asia and Australia. Four species are endemic to Australia and are found in the west and east of the country.

Geijera parviflora (wilga) *See Geijera*.

Gekko gecko (tokay gecko, great house gecko; order Squamata, suborder Sauria (Lacertilia), family Gekkonidae) One of the largest geckos, which grows up to 35 cm long. Its common name mimics its call, 'to-kay'. A strong, aggressive lizard, it feeds on insects, small reptiles, mammals, and birds. It is common in SE Asia and Indonesia.

Gekkonidae (geckos; order Squamata, suborder Sauria (Lacertilia) Family of insectivorous, mainly nocturnal lizards in which the eye has a vertical pupil and spectacle (no eyelids). The skin is soft with sparse horny tubercles. The toes usually have transverse rows of hooked lamellae for adhesion. The tail is used as a fat store, and is capable of autotomy. There are more than 400 species, distributed widely in warm latitudes.

Gelechiidae (order Lepidoptera) Large, widespread family of small moths. The distal edge of the hindwing is usually sinuate. Larvae feed among leaves, which they spin together, or on seeds, or internally in stems. Occasionally they are leaf-miners. Pupation occurs in the larval shelter or on the ground. Many species are pests.

gel filtration Column-chromatographic technique normally employing as a stationary phase polymeric carbohydrate-gel beads of controlled size and porosity. Mixture components are separated on the basis of their sizes and rates of diffusion into the beads. Smaller molecules tend to diffuse more rapidly into the beads, thereby leaving the mainstream of solvent and so becoming retarded with respect to larger molecules. This method can also be used to determine the molecular weight of an unknown substance.

Gelidiales (class Rhodophyceae) Order of red seaweeds, in which the thallus is filamentous, cylindrical or compressed, and typically is branched. Several species are of economic importance as sources of agar. There are two British genera, *Gelidium* and *Pterocladia*. Three British species of *Gelidium* are currently recognized, but these are notoriously variable and difficult to identify. They are very common in intertidal regions, often forming a fringe around rock pools.

gelifluction Flow of water-saturated sheets of rock debris over perennially frozen ground, and on slopes as low as 1°. It is the cold-climate variety of solifluction and occurs only in the active layer (to a depth of 3 m).

gelifraction *See* frost wedging.

geliturbate *See* geliturbation.

geliturbation General term for all frost-based movements of the regolith, including frost heaving and gelifluction. The material disturbed by such movements is called 'geliturbate'.

gemfish (*Rexea solandri*) *See* Gempylidae.

gemma 1 (mycol.) Thick-walled, asexually-derived spore formed from a portion of a vegetative hypha. 2 (bryol.) Structure formed by certain mosses and liverworts, which functions in vegetative reproduction. Gemmae may consist of one, two, or many cells. *See also Marchantia*; *Lunularia*; and Tetraphidales.

gemmation *See* asexual reproduction; budding; and gemma.

Gempylidae (snake mackerel, gemfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, coastal to oceanic

fish which have a very elongate, sometimes ribbon-like body; a large mouth provided with strong teeth; and long, low first dorsal and short second dorsal fins. Secondary small finlets may occur anterior to the forked tail-fin. *Gempylus serpens* (snake mackerel), 1.5 m in length, is a fast swimmer and has a worldwide distribution. Several species are of commercial importance, including *Rexea solandri* (gemfish) of E. Australia. There are about 20 species, found in tropical to temperate waters, worldwide.

Gempylus serpens (snake mackerel) *See* Gempylidae.

gemstone Naturally occurring mineral that has been artificially polished, faceted, and shaped for decorative purposes. It is classified normally as precious (e.g. diamond, ruby, and emerald) or semi-precious (e.g. garnet, zircon, and topaz). Many gemstones are hard, clear, and free from natural imperfections.

gendarme *See* arête.

gene Fundamental physical unit of heredity. It occupies a fixed chromosomal locus, and when transcribed has a specific effect upon the phenotype. It may mutate, and so yield various allelic forms. A gene comprises a segment of DNA (in some viruses it is RNA) coding for one function or several related functions. The DNA is usually situated in thread-like chromosomes, together with protein, within the nucleus; in bacteria and viruses, though, the chromosomes comprise simply a long thread of DNA. The part of a gene that functions as one unit is called a cistron.

gene flow Movement of genes within an interbreeding group that results from mating and gene exchange with immigrant individuals. Such an exchange of genes may occur in one direction or both.

gene frequency The number of loci at which a particular allele is found divided by the total number of loci at which it could occur, for a given population, expressed as a proportion or percentage.

gene pool The total number of genes, or the amount of genetic information, that is possessed by all the reproductive members of a population of sexually reproducing organisms.

general adaptation Adaptation that fits an organism for life in some broad environmental zone, as opposed to 'special adaptations' which are specializations for a particular way of life. Thus the wing of a bird is a general adaptation, while the particular kind of bill is a special adaptation. Major groups of organisms are differentiated very largely on the basis of general adaptations.

general-adaptation syndrome (GAS) A range of abnormal physiological systems reflecting pathological social stress, and serving to regulate population growth, where no external resource limitation exists. Essentially it is a behavioural regulation of population growth. Mechanisms include the suppression of the oestrous cycle, inadequate lactation, enlarged adrenal glands, increased aggression, etc. It has been demonstrated experimentally with overcrowded laboratory rats.

general circulation The term generally used to describe the large-scale circulation of the atmosphere over the globe, or over one hemisphere, with its more or less persistent features (which may be brought to prominence by considering long-term, or even shorter-term, averages), and all the transient features on various scales. Although in its nature it is a matter of the winds, the general circulation may be studied by means of barometric pressure maps because of the intimate relation between pressure and wind.

generalization (ethol.) Evocation of a learned pattern of behaviour by stimuli other than those to which an animal was trained to respond.

generation time Time required for a cell to complete one full growth cycle. If every cell in the population is capable of forming two daughter cells, has the same average generation time, and is not lost through lysis, the doubling time of the cell number in a population will equal the generation time.

generic cycles, theory of Theory which envisages a life cycle for a species or genus that resembles that of an individual. The first stage is characterized by vigorous spread; the second by maximum phyletic activity giving rise to new forms; the third marks a phase of decline in area due to competition within the offspring species; and the fourth and final stage sees the extinction of the species. Although in many ways a useful analogy, there is no evidence that species become senile and die out spontaneously.

gene substitution The replacement of one gene by an allele while all other relevant genes remain unchanged.

genetic code The set of correspondences between base (nucleotide pair) triplets in DNA and amino acids in protein. These base triplets carry the genetic information for protein synthesis. For example, the triplet CAA (cytosine, adenine, adenine) codes for valine.

genetic drift The random fluctuations of gene frequencies in a population such that the genes amongst offspring are not a perfectly representative sampling of the parental genes. Although drift occurs in all populations its effects are most marked in very small isolated populations, in which it gives rise to the random fixation of alternative alleles so that the variation originally present within single (ancestral) populations comes to appear as variation between reproductively isolated populations.

genetic engineering Manipulation of DNA using restriction enzymes which can split the DNA molecule and then rejoin it to form a hybrid molecule—a new combination of non-homologous DNA (so-called recombinant DNA). The technique allows the by-passing of all the biological restraints to genetic exchange and mixing, and may even permit the combination of genes from widely differing species. Genetic engineering developed in the early 1970s, and has become one of the most fertile areas of genetics.

genetic equilibrium Equilibrium in which the frequencies of two alleles at a given locus are maintained at the same values generation after generation. A tendency for the population to equilibrate its genetic composition and resist sudden change is called genetic homoeostasis.

genetic homoeostasis *See* genetic equilibrium.

genetic load The average number of lethal mutations per individual in a population. Such mutations result in the premature death of the organisms carrying them. Three main kinds of genetic load may be recognized: (a) input load, in which inferior alleles are introduced into the gene pool of a population either by mutation or immigration; (b) balanced load, which is created by selection favouring allelic or genetic combinations that, by segregation and recombination, form inferior genotypes every generation; (c) substitutional load, which is generated by selection favouring the replacement of an existing gene by a new allele. Originally called the 'cost of natural selection' by the geneticist J. B. S. Haldane, substitutional load is the genetic load associated with transient polymorphism. The term 'genetic load' was originally coined by H. J. Muller in 1950 to convey the burden that deleterious mutations provide, but it is probably better recognized as a measure of the amount of natural selection associated with a certain amount of genetic variability, which provides the raw material for continued adaptation and evolution.

genetic map The linear arrangement of mutable sites on a chromosome, deduced from genetic-recombination experiments. The percentage of recombinants is used as a quantitative index of the distance between two gene pairs, and this distance, together with those between other gene pairs, provide a map of their arrangement on the chromosome. One 'genetic map unit' is defined as the distance between gene pairs for which one product of meiosis out of one hundred is recombinant (i.e. it equals a recombination frequency of 1%).

genetic polymorphism Occurrence in a population of two or more genotypes in frequencies that cannot be accounted for by recurrent mutation. Such occurrences are generally long-term. Genetic polymorphisms may be balanced (such that allele frequencies are in equilibrium with one another at a given locus), or transient (such that a mutation is spreading through the population in a constant direction). In the former case, the different alleles may be maintained by different environmental conditions (in space or time), one being favoured under one set of circumstances and another under another set; or a heterozygous genotype may be in some way superior to the genotypes that are homozygous at that locus—this is termed a 'heterozygous advantage'.

genetics The scientific study of genes and heredity.

genetic system The organization of genetic material in a given species, and its method of transmission from the parental generation to its filial generations.

genetic variance Portion of phenotypic variance that results from the varying genotypes of the individuals in a population. Together with the environmental variance, it adds up to the total phenotypic variance observed amongst individuals in a population.

geniculate 1 Kneed. 2 *See* flagellum (3).

genital capsule Those organs, and all their associated sclerites, that are used for the transfer of sperm in a male insect. The genital capsule is made up of a number of abdominal segments. In male *Oncopethus*, for example, sclerites from segments 7–11 are involved.

genitus Growth of a new cloud from a mother-cloud, where only a limited part of the mother-cloud is affected by the change. *See also* cloud classification; and mutatus.

genome The total genetic information carried by a single set of chromosomes (i.e. in a haploid nucleus). A single representative of each of all the chromosome pairs in a nucleus will therefore bear the genome of an individual.

genotype Genetic constitution of an organism, as opposed to its physical appearance (phenotype). Usually this refers to the specific allelic composition of a particular gene or set of genes in each cell of an organism, but it may also refer to the entire genome.

genotypic adaptation *See* adaptation.

gentian (*Gentiana*) *See* Gentianaceae.

Gentiana (gentian) *See* Gentianaceae.

Gentianaceae Family of hairless herbs with simple, opposite leaves, bell-shaped or wheel-shaped corollas, and superior ovaries of two partly-fused carpels. There are about 65 genera, with 800 species, centred on northern temperate regions, but extending far south down the Andes into S. America. *Gentiana* (gentian) has more than 200 species, centred in the mountains of Europe, many of which are prized for their splendid, blue flowers.

Gentianella (family Gentianaceae) Genus of annual and perennial herbs with opposite, entire leaves without stipules, which are usually sessile. The plants are glabrous. The flowers are regular and bisexual. The calyx is lobed; the corolla a cylindrical tube and usually white, blue, or purple, composed of four or five petals. There are four or five stamens. The ovary is superior, unilocular with numerous ovules. The style is sometimes absent. The fruit is a capsule containing many small seeds. There are 125 species, found in all temperate regions except Africa. Most species occur on mountain grassland, calcareous pastures, and in coastal habitats.

Genypterus capensis (kingklip) *See* Ophidiidae.

geo Narrow inlet of a cliffed coastline, which has developed along a major near-vertical joint or fault.

geobotanical exploration (biogeochemical exploration) Traditionally, the use of indicator plant species or assemblages to detect the possible presence of metal-rich deposits. It is based on the

limits-of-tolerance principle, i.e. it assumes that only specialized species can withstand metal-contaminated soils. In practice, plant response may be confusingly more complex—e.g. plants may respond to low availability of essential nutrients rather than to high presence of toxic minerals—which makes such indicators unreliable. In modern use the concept includes the collection and chemical analysis of plant materials or soil layers, especially humus, in which metal ions may accumulate. It is a supplementary rather than a primary prospecting method. *See also* limiting factor; and limits of tolerance.

geochemistry Branch of geology concerned with all aspects of the chemistry and physico-chemical processes that control and have controlled the evolution of the Earth. The field is very large and has many specializations, e.g. the elemental compositions of rocks, minerals, and soils; experimental petrology; and petrological theories regarding the evolution of rocks and mineral deposits.

geochronology Determination of time intervals on a geological scale, through either absolute or relative dating methods. Absolute dating methods involve the use of radioactive elements and knowledge of their rates of decay: this yields an actual date in years for a given rock or fossil. Relative dating involves the use of fossils or sediments to place events and rock sequences in order, and does not provide absolute dates. *See also* dating methods.

geochronometry Determination of the length of time intervals. Geochronometric resolutions for zonations based on different organisms may be calculated by dividing the timespan of a series by the number of zones and the intervals between zones. However, this will give only an approximate measure of time. *See also* dating methods; and geochronology.

Geococcyx californianus (greater roadrunner) *See* Cuculidae.

geode Hollow, rounded body, which has a lining of crystals pointing inward. The minerals lining the hollow may be quartz, calcite, or some other mineral.

Geoglossaceae (order Helotiales) Family of fungi, which form stalked, club-shaped fruit bodies (commonly called 'earth-tongues'). They are saprotrophic, and found mostly on the ground, but also on rotting wood or leaves.

geographical floral element Group of plant species that has marked geographical affinities. The flora of a given territory includes different geographical elements. For example, the Mediterranean element in the British flora comprises 38 species, concentrated in the extreme south and south-west of England. The majority are flowering annuals or biennials, categories of plants well represented in the sunny Mediterranean. When the full ranges of the 38 species is examined, they are all found to occur in the Mediterranean basin, with northerly extensions to Britain.

geometers *See* Geometridae.

Geometridae (geometers, loopers, earth measurers, inch worms, carpet moths, waves, pugs; order Lepidoptera) Huge family of small to medium-sized, often cryptically coloured moths, with a slender body and relatively broad wings. In the females of some species the wings are reduced. All or some abdominal 'legs' are absent from the larvae, except for the last pair. The larvae frequently resemble twigs and progress in a looping fashion. There are about 12 000 species. The family has a worldwide distribution.

Geomyidae (pocket gophers; order Rodentia, suborder Sciuromorpha) Family of colonial burrowing rodents in which the body is thickset. There are five clawed digits on each limb, the claws of the forelimbs being especially strong. The tail is short, with sparse hair. There are many species, confined to N. and C. America.

Geonoma (family Palmae) Genus of small, sometimes minute, abundant undergrowth palms, many of which form clumps. The leaves are pinnately nerved, simple, or divided into broad or narrow leaflets. The palms are monoecious. The inflorescence is branched or simple. *Geonoma* are little known in cultivation. There are 75 species, found in lowland and mountain forests of tropical America.

geophysics Branch of geology concerned with all aspects of the physical properties and processes of the Earth and their interpretation, including, for example, seismology, gravity, magnetism, heat flow, and geochronology.

geophyte Land plant that survives an unfavourable period by means of underground food-storage organs, e.g. rhizomes, tubers, and bulbs. Buds arise from these to produce new aerial shoots when favourable growth conditions return.

geostrophic current Ocean current that is the product of a balance between gravitational forces and the Coriolis effect. Geostrophic currents move water horizontally below the depth to which wind effects can penetrate.

geostrophic wind Moving air is acted upon by a number of forces, which are commonly nearly in balance with each other. (a) A force due to the pressure gradient acts at any point directly from the region of higher pressure towards the region of lower pressure. (b) The Coriolis, or geostrophic force, due to the rotation of the Earth, tends to turn the air to the right (in the northern hemisphere; to the left in the southern hemisphere) of a 'straight' (great circle) path. (c) A centrifugal force, which is due to the curvature of the air's path around a centre of low or high pressure. (d) Other forces, including that exerted by the friction of the ground. The geostrophic wind is the wind that, by its strength and direction, represents the balance between the first two of these forces (which are often the only significant ones in the free air), the pressure-gradient force and the geostrophic force. *See also* gradient wind.

geosyncline Large, downwarp structure generally of considerable extent, which may develop along a

continental margin. The term was introduced originally by James Hall in 1859, and later an elaborate terminology was developed to describe and interpret the component parts. Many of these have fallen into disuse since the replacement of geosynclinal theory by the more unifying theory of plate tectonics.

geotaxis Change in direction of locomotion, in a motile organism or cell, made in response to the stimulus of gravity.

geothermal field Area of the Earth characterized by a relatively high heat flow, due to present or fairly recent orogenic or ocean-ridge activity. Hot springs and fumaroles may be surface manifestations of a geothermal field.

Geothlypis (yellowthroats, warblers; family Parulidae) Genus of small, mainly yellow and olive birds, the males of some having black facial masks. They are found in woodland undergrowth, clearings, and damp thickets. They are insectivorous, and ground-nesting. There are 14 species, mainly migratory, found in N., C., and S. America. Some are placed in a separate genus, *Oporornis*.

geotropism Directional movement of a plant in response to the stimulus of gravity. Primary tap roots show positive geotropism; vertical primary shoots show negative geotropism; horizontal stems and leaves are diageotropic; and branches and secondary roots at oblique angles are plagiogeotropic.

Geotrupidae (dung beetles, dor beetles; class Insecta, order Coleoptera) Family of robust, shiny, black or brown beetles, 7–27 mm long. The head and thorax of the male often have projections, those of females much less commonly so. The antennae are clubbed. The broad, toothed tibiae are used for digging. Eggs are laid in tunnels beneath patches of dung, and dung is carried down to feed larvae; in some species the sexes co-operate. Larvae are white and fleshy, with little reduction of legs. Both adults and larvae stridulate. Some species may feed on underground fungi, others on plants. There are 300 species.

Geotrygon (quail doves; family Columbidae) Genus of plump, purple-brown doves with long legs. They are mainly terrestrial, inhabiting forests; they feed on seeds, fruit, and insects, and nest low in trees or shrubs. There are 13 species, found in C. and S. America.

Geraniaceae Family of herbs or low shrubs, rarely tree-like, with alternate lobed or compound stipulate leaves. The flowers are regular, usually pentamerous with free petals and sepals, and usually with twice as many stamens as petals; they have a superior 3–5-celled ovary, and there is usually a long beak bearing the free stigmas. The fruit is a lobed capsule, the lobes usually one-seeded, sometimes separating. There are some 11 genera, with 700 species, in temperate and tropical zones; garden 'geraniums' are *Pelargonium* species from S. Africa, with slightly irregular, spurred flowers.

gerbil *See* Cricetidae.

German cockroach *See Blattella germanica*.

German measles (rubella) Acute, infectious disease of humans which is normally mild, involving a skin rash and enlargement of the lymph nodes. However, if contracted during the first 3–4 months of pregnancy, permanent damage to the foetus may occur. The disease is caused by a virus of the Togaviridae.

German wasp *See Vespula germanica*.

germ cell *See* germinal selection.

germinal disc *See* blastodisc.

germinal selection 1 Selection of germ cells (sex cells from which gametes are derived) that possess recognized superior qualities, for use in the production of a subsequent generation. This method is used by humans for their domesticated animals; and it is proposed by those supporting eugenics that the method should also be applied to humans. In the latter case, germ cells would be stored, frozen, in germ banks, and would be available for couples who wished to use them rather than their own germ cells to generate a family. 2 Selection during gametogenesis against induced mutations that retard the spread of mutant cells.

germination The beginning of growth of a seed or spore, usually following a period of dormancy, and generally in response to the return of favourable external conditions, most notably warmth, moisture, and oxygen. The internal biochemical status of the seed or spore must also be appropriate. In seeds, germination may be epigeal, with cotyledons emerging above the ground, or hypogeal, with the cotyledons staying below ground.

germ line Cells from which gametes are derived, and which therefore bridge the gaps between generations, unlike somatic cells, in the body of an organism.

germ plasm The hereditary material transmitted to offspring through the germ cells, and giving rise in each individual to the somatic (body) cells.

Gerreidae (mojarra, silver biddy; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of small marine fish, which have an oblong to deep, silvery body; a small, protractile mouth with tiny teeth; a long dorsal fin, a forked tail-fin, and long, pointed pectorals. They inhabit coastal tropical to subtropical waters. There are about 40 species, found worldwide.

Gerridae (pondskaters; order Hemiptera, suborder Heteroptera) Family of bugs which live on the surface of lakes, ponds, slow rivers, and even the open sea. The legs and body are water-repellent, and so unwettable, and the insects are supported by surface tension. Their food consists mainly of drowning insects. There are about 400 species.

Gesneriaceae (order Scrophulariales) Large family of herbs and shrubs, some of which are epiphytic. The leaves are simple, opposite, alternate, or basal. The flowers are irregular, borne in inflorescences or singly, with five sepals and five petals forming a tube. Many are pollinated by hummingbirds. The

fruits are usually capsules. The family includes many ornamentals, e.g. African violets and gloxinias. There are about 125 genera, with 2000 species, mostly tropical.

gestation period Length of time from conception to birth in a viviparous animal; usually a relatively fixed period for a particular species.

gharials 1 *See* crocodilians; and Crocodilidae. 2 (false gharial) *See* Gavialidae.

GHOST *See* Global Horizontal Sounding Technique.

ghost-faced bats *See* Mormoopidae.

ghostfish *See* Chimaeridae.

ghost flathead *See* Hoplichthyidae.

ghost moths *See* Hepialidae.

ghost pipefish *See* Solenostomidae.

giane *See* Mediterranean scrub.

giant American lobster *See Homarus americanus*.

giant barracuda (*Sphyraena barracuda*) *See* Sphyraenidae.

giant dragonfly *See Meganeura gracilipes*.

giant girdled lizard *See Cordylus giganteus*.

giant gourami *See* Osphronemidae.

giant herring *See* Elopidae.

giant manta (*Manta birostris*) *See* Mobulidae.

giant maori wrasse (*Cheilinus undulatus*) *See* Labridae.

giant perch (*Lates calcarifer*) *See* Centropomidae.

giant salamanders 1 *See* Cryptobranchidae. 2 (Japanese giant salamander) *See Andrias japonicus*.

giant spider crab *See Macrocheira kaempferi*.

giant spiny lobster *See Jassus heugeli*.

giant swamp taro (*Cyrtosperma chamissonis*) *See Cyrtosperma*.

giant taro (*Alocasia macrorhiza*) *See Alocasia*.

giant tortoises 1 (Galápagos giant tortoise) *See Testudo elephantropus*. 2 (Seychelles giant tortoise) *See Testudo gigantea*.

giant wels (*Silurus glanis*) *See* Siluridae.

giardiasis Acute or chronic diarrhoea due to infection with the protozoon *Giardia lamblia*.

gibberellin Generic term for a group of plant hormones that stimulate the growth of leaves and shoots. They are thought to act either at a transcriptional level or as inducers of enzymes.

gibbon (*Hylobates*) *See* Hylobatidae.

Gigantactinidae (class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of deep-sea angler fish, with unusually-shaped elongate bodies and large tail-fins. The very long illicium ('fishing rod') at the tip of the snout of the female is a conspicuous feature. There are about five species, which can be found at depths exceeding 1000 m.

Giganthuridae (class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of deep-sea fish, all of which have a large mouth with depressible teeth, tubular, telescopic eyes, a scaleless body, high pectoral fins, and a long lower lobe of the forked tail-fin. The small giganthurids (15 cm) occur at depths exceeding 2000 m. There are five species, found worldwide.

Gigantochloa (family Gramineae, subfamily Bambusoideae) Genus of 20 species of giant bamboos, occurring in Indo-Malaysia, many of which are used for building.

Giganto productus *See Productus giganteus*.

Gigartinales (class Rhodophyceae) Order of red seaweeds, in which the thallus is crustose (Cruoriaceae) or cylindrical, compressed or membranaceous, and branched or unbranched. There are many families and genera. *Gigartina stellata* is a common species which forms dense, dark-red tufts on rocks in the intertidal zone, often occurring in dense colonies. This species has been used commercially as a source of agar.

gila monster *See Heloderma suspectum*.

Gilbert's synaphobranchid (*Synaphobranchus brachysomus*) *See* Synaphobranchidae.

gilgai Undulating micro-relief of soils containing large amounts of clay minerals, e.g. montmorillonite, that swell and shrink considerably on wetting and drying, to an extent that may be sufficient to fracture pipelines or move telegraph or fence poles from the vertical. The word is derived from a settlement in Queensland, Australia, where the soils of swelling clays are especially common. *See also* patterned ground.

gill 1 (mycol.) Membranaceous, blade-like structure (lamella) which bears the hymenium in the fruit body of a mushroom or other agaric. Gills are usually arranged radially on the under-side of the pileus. 2 (zool.) Respiratory organ of an aquatic animal, often complex in form, consisting of an outgrowth from the body surface or an internal layer of modified gut, past which water flows: it provides a large surface area, well supplied with blood vessels, across whose walls oxygen and carbon dioxide diffuse. It is the chief organ of respiration in fish, in which the gills are usually supported by four or more pairs of bony or cartilaginous gill arches. In sharks each gill is more or less surrounded by a separate gill chamber, but in bony fish the gills share a common gill (branchial) chamber, one on each side of the head. Each gill arch bears rows of platelike filaments, in turn carrying secondary lamellae, which are capable of absorbing oxygen from the water flowing over the surface.

gill arch (branchial arch) *See* gill (2).

gill book Gills composed of a series of plates, resembling the pages of a book.

gill cover Hard but flexible cover (operculum) which, in bony fish, forms the outer wall of the gill chamber. It not only protects the gills, but also plays a major role in the pumping mechanism that regulates the continuous flow of water over the gills.

gill-footed shrimps *See* Branchiopoda.

gill pouch Part of the respiratory system of lampreys and hagfish, which have a row of gill pouches on each side of the head. A gill pouch consists of a muscular wall with many respiratory lamellae lodged on its inner side. In lampreys the gill pouches each have a separate opening to the exterior.

gill raker Gills of most bony fish carry not only numerous filaments, but also, on the inner side of the gill arch, a row of gill rakers: fairly stiff, tooth-like processes, which strain the water flowing past them. In some fish (e.g. mullet and herring) the gill rakers are long and closely set, thereby acting as a sieve capable of retaining food particles.

gilsonite (asphaltite) Solid form of hydrocarbon which occurs as pure, natural bitumen, specific gravity 1.05–1.10, hardness 2.0. It is black in colour and distinguished by its low specific gravity and low hardness. On heating it softens rapidly and flows like a liquid. It can occur in veins, lodes, and sedimentary rocks. It is used in waterproof coatings, wire insulations, and lacquer.

ginger *See* Zingiberaceae.

gingerbread palm (doum palm, *Hyphaene thebaica*) *See Hyphaene*.

Ginglymodi Older name for the American gars (*Lepisosteus*). *See* Lepisosteidae.

Ginglymostoma cirratum (Atlantic nurse shark) *See* Orectolobidae.

Ginkgo Genus whose sole living member, *G. biloba*, is the maidenhair tree of the gymnosperm family Ginkgoaceae, native in E. Asia. It is deciduous, has leaves with open dichotomous venation, and is dioecious. The naked seed is oily and edible but the testa and embryo are bitter. It is widely cultivated. Many fossil species are known. *G. digitata* is first recorded from the Middle Jurassic. It is the earliest representative of the genus and bears a close resemblance to its living relative.

Ginkgoales (maidenhair tree) A subdivision of the Coniferopsida, one of the three major gymnosperm groups. Only one species of *Ginkgo* survives, *Ginkgo biloba*. The first undoubted maidenhairs occur in Triassic rocks, and in the subsequent Jurassic Period their distribution was practically worldwide. The surviving species is restricted (in the wild) to China, and its leaves are strikingly similar to fossil *Ginkgo* leaves from the Triassic. The restricted geographical range, the unchanged appearance of the leaves, and the motile male sperms (otherwise known only in living seed plants in the Cycadales) have together led to the maidenhair being referred to as a 'living fossil'.

ginseng *See Panax*.

giraffe (*Giraffa camelopardalis*) *See* Giraffidae.

Giraffidae (giraffe, okapi; order Artiodactyla, suborder Pecora, superfamily Cervoidea) An artiodactyl family, now represented by only the giraffe and okapi of Africa, which diverged from the Cervidae during the Miocene. Relatively short-necked and short-legged forms like the okapi are known as fossils from the Pliocene of Eurasia, and in the Pleistocene of Africa and S. Eurasia there were very large, heavily built giraffids with branched horns, the best-known example being *Sivatherium*. The okapi is almost indistinguishable from the Pliocene genus *Palaeotragus*. Both sexes bear short horns covered by skin, but extinct forms grew larger horns (e.g. *Samotherium* and *Sivatherium*). Giraffidae are long-legged, and in the giraffe (*Giraffa camelopardalis*) the weight of the body is balanced on the forelimbs, the number of ribs is reduced, and the hind part of the spinal column functions as part of the hind limbs, which provide propulsion. The gait is 'rocking', both limbs of one side of the body moving together. There are mechanisms that regulate blood flow when the head is raised. There are two genera (*Giraffa* and *Okapia*), found in Africa south of the Sahara.

girdled lizard (giant) *See Cordylus giganteus*.

girdle-tailed lizards *See* Cordylidae.

girdling Cutting transversely across the vascular tissue in a stem so that downward transport of substances is unable to occur within the plant. The term is used when a tree is cut right around its circumference to a depth that penetrates through the bark and into the wood: the tree is thus killed.

Girella tricuspidata (luderick) *See* herbivorous fish; and Kyphosidae.

Givetian Well-known stage of the Devonian that is zoned on goniatites and spiriferid brachiopods. Together with the underlying Eifelian (Emsian and Couvinian) it forms the Middle Devonian.

gizzard shad (*Dorosoma cepedianum*) *See* Clupeidae.

glabella The part of the head that is posterior to or above the eyes, and that is more or less smooth and hairless.

glabrous Smooth, lacking hairs.

glacial breach Glacially-eroded trough cut by ice that locally spills over the surrounding watershed from a zone of accumulation ('ice cauldron'). The process is called 'glacial diffluence' and is common in areas of contemporary glaciation, e.g. Alaska and Greenland, and is also important in areas of Pleistocene glaciation.

glacial diffluence *See* glacial breach.

glacial diversion Displacement of a pre-glacial stream by the action of a glacier. In upland areas the new drainage often follows a glacial breach. In lowlands, glacial drift may block an existing valley and lead to stream diversion.

glacial stairway Long-profile of a glacial trough: it is characterized by alternating rock bars and basins, giving the impression of a stairway. The structure is attributed to variations in the erosive power of ice, or to the influence of rock jointing.

glaciation The covering of a landscape or larger region by ice; an ice age.

glacier *See* cold glacier; and temperate glacier.

glacier wind *See* firn wind.

glacio-eustasy (glacio-eustatism) The theory that sea-levels rise and fall in response to the melting of ice during interglacials and the accumulation of ice during glacials. A major glacio-eustatic oscillation has an amplitude of some 100 m.

glacio-isostasy Theory that a sufficiently large ice sheet can significantly depress the Earth's crust, which subsequently rises again when the ice melts. Some 1000 m of depression may have occurred in Scandinavia, where 520 m of recovery has been recorded. The process gives rise to warped shorelines.

glaciomarine sediment High latitude, deep-ocean sediment, which originated in glaciated land areas and has been transported to the oceans by glaciers or icebergs. Such sediments may contain large dropstones, transported by and dropped from icebergs, in the midst of fine-grained sediments.

Gladiolus (family Iridaceae) Genus of herbs produced from corms, with showy, irregular flowers, each enclosed in its own spathe on the spike-like inflorescence. There are some 120 species, in Europe, Asia, and Africa; African species are those most grown in gardens.

glanders Disease of horses and related animals; symptoms include fever, prostration, and nasal discharge. The disease may be fatal if untreated. The causal agent is *Pseudomonas mallei* (formerly called *Actinobacillus mallei*). *See Pseudomonas*.

glandular fever (infectious mononucleosis) Acute, infectious disease which affects mainly young adult humans; symptoms include enlargement of lymph nodes and the presence of abnormal white blood cells. The disease is caused by the Epstein–Barr virus.

Glareolidae (pratincoles, coursers; order Charadriiformes) Family of mainly brown and grey birds with white under-parts and distinctive facial and wing markings. Pratincoles have four toes; short bills and legs; long, pointed wings; and forked tails. Coursers have three toes; longer bills; short, broad wings and tails; and long legs. Most have their middle toe pectinate. They inhabit bare, stony areas, coursers being terrestrial and pratincoles more aerial; they feed on insects, and nest on the ground. There are five genera, with 16 species, found in Europe, Africa, Asia, and Australia.

glass Igneous, non-crystalline material that originated by the rapid cooling of a melt.

glass catfish (*Kryptopterus bicirrhis*) *See* Siluridae.

glassfish *See* Salangidae.

glass snake *See Ophisaurus apodus*.

glasswort *See Salicornia*.

Glaucidium (pygmy owls, owlets; family Strigidae) Genus of small owls, some just bigger than a sparrow, which are partly diurnal, inhabiting forests, and feed on mammals, birds, and insects, some prey being caught on the wing. They nest in holes. There are 13–15 species found in Europe, Africa, Asia, and N., C., and S. America.

glauconite Hydrous potassium-iron-aluminosilicate clay mineral, which occurs in marine sediments as light- to dark-green aggregates up to 1 mm in diameter. It is being formed on many modern continental shelves, at depths from a few tens to hundreds of metres, where the sedimentation rate is low and decaying organic matter is present in a generally oxidizing environment. In many sandstones glauconite can impart a green colour when abundant, as in the Cretaceous Greensands of Britain and the eastern USA.

glaucophane *See* blueschists.

Glaucosoma hebraicum (jewfish) *See* Glaucosomidae.

Glaucosoma scapulare (pearly perch) *See* Glaucosomidae.

Glaucosomidae (pearl perch; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine coastal fish which have a robust, deep body, large mouth, and large eyes. Both *Glaucosoma scapulare* (pearl perch) of E. Australia and the W. Australian *Glaucosoma hebraicum* (jewfish), 1 m in length, are highly rated food fish. There are about five species, found in the W. Pacific region.

glaucous Sea-green or bluish-green in colour, or having a waxy, bluish-green bloom, as on a plum. Originally the word meant bright, sparkling, greyish, like the eyes of Pallas Athene.

glaze Clear-ice deposit on objects, produced by the freezing of supercooled water droplets on to surfaces at temperatures below 0 °C. *See* clear ice.

Gleason, H. A. *See* individualistic hypothesis; and similarity coefficient.

gleba Spore-bearing tissue within the fruit bodies of members of the Gasteromycetes and Tuberales.

Gleicheniaceae Family of ferns with long rhizomes, and regularly-forked, branching leaves, with gradate, naked, superficial, rosette-like sori. They are known from the Coal Measures of the Carboniferous Period and are now of wide tropical distribution; five genera are now accepted.

glenoid cavity In tetrapods, the socket in the pectoral girdle into which the head of the humerus fits.

glenoid fossa Smooth depression on the ventral side of the skull into which the condyle of the jaw bone fits.

gley The product of waterlogged soil conditions, and hence an anaerobic environment; it encourages the reduction of iron compounds by micro-organisms and often causes mottling of soil into a patchwork of grey and rust colours. The process is known as gleying, or gleyzation (US usage).

glial cell Type of cell that occurs in vast numbers in the central nervous system, surrounding and separating neurones and their processes. Apparently, the role of glial cells is to act as mediators of normal neuronal metabolism and/or as insulators between neurones to prevent unwanted interactions.

gliding tectonics *See* gravity tectonics.

Glires (class Mammalia, subclass Theria, infraclass Eutheria) Cohort comprising mammals possessing incisors that are 'rootless', i.e. incisors that continue to grow throughout life and are worn away by gnawing. The cohort includes the orders Rodentia and Lagomorpha, presumed to have diverged from the insectivorous eutherian stock during the Cretaceous and subsequently differentiated into rodent and lagomorph forms; but similarities between the two orders may be superficial, implying no close relationship, so their inclusion in a single cohort is somewhat arbitrary.

Gliricidia (family Leguminosae, subfamily Papilionatae) Genus of trees with pinnate leaves, which smell of coumarin when dry. *G. sepium* (Mexican lilac) is widely cultivated. There are four species, native to tropical America.

Gliridae (dormice; order Rodentia, suborder Myomorpha) Family of small, mainly arboreal, nocturnal rodents. The snout is often elongated; the eyes and ears are well developed; the tail is bushy; and the first digit of the forelimb is rudimentary. Dormice have lower population densities and lower breeding potential than most other rodents, and most hibernate in winter. There are seven genera, with many species, distributed throughout the Palaearctic Region and Africa.

Global Atmospheric Research Programme (GARP) International project that aims to provide comprehensive knowledge of atmospheric structure as an aid to prediction. The complex system is based on land and marine weather stations, together with upper-air soundings, satellite remote-sensing, and sensors carried by balloons.

Global Horizontal Sounding Technique (GHOST) Programme for direct sensing of the atmosphere, using balloons designed to float at various constant-density levels. These are tracked and their various measurement readings are monitored by polar orbiting satellites. Sensors on the balloons record temperature, humidity, and pressure; tracking gives mean winds for each balloon. The project forms part of the World Weather Watch.

globe thistle *See Echinops*.

Globicephala melaena (pilot whale) *See* Delphinidae.

Globigerina (order Foraminiferida) Protozoan genus whose members are commonly planktonic, unlike most foraminiferans, which are benthic. *Globingerina* species have more delicate shells than benthic foraminiferans and the shells often have spines.

***Globigerina* ooze** Deep-sea ooze in which at least 30% of the sediment consists of planktonic foraminifera including chiefly *Globigerina*. It is the most widespread pelagic deposit, covering almost 50% of the deep-sea floor. *Globigerina* ooze covers most of the floor of the western Indian ocean, the mid-Atlantic Ocean, and the equatorial and S. Pacific.

Globorilida (phylum Mollusca, class Calyptoptomatida) Order of smooth, unornamented calyptoptomatids which have globular embryonic chambers. The shell is curved, more so at the apex, and is normally circular in cross-section. The interior morphology is unknown. Globorilida are found only in rocks of Middle Cambrian age.

globose Spherical.

Globulariaceae Small family of herbs with leaves mostly in a basal rosette, and tiny flowers aggregated into disc- or dome-shaped heads. The ovary is superior, the corolla tube is five-lobed and two-lipped, and there are four stamens and two stigmas. There are two genera, with about 30 species, mainly from Europe, N. Africa, and the Near East; and they are cultivated for their flowers.

globular protein Protein in which at least one polypeptide chain is folded in a three-dimensional globular configuration. The stability of the structure is maintained by a number of intra-chain bonds. Globular proteins have a variety of functions, e.g. acting as enzymes, facilitating transport, and providing storage.

globulin One of a group of globular, simple proteins, which are insoluble or only sparingly soluble in water, but soluble in dilute salt solutions. They occur in many animal tissues and in plant seeds, where they have a variety of functions.

glochidia *See* Azollaceae.

Gloeocapsa (order Chroococcales) Genus of cyanobacteria. The cells lie in small packets embedded in mucilage, which shows a layered structure. They are found in masses on wet rocks.

Gloger's rule Individuals of many species of insects, birds, and mammals are darkly pigmented in humid climates and lightly coloured in dry ones. This may well be a camouflage adaptation—moist habitats are usually well vegetated and tend to lack pale colours. There are many exceptions to this so-called rule.

Gloriosa (family Liliaceae) Genus of herbaceous, tendrillate climbers, which have swollen tubers and showy flowers. Cultivated *G. superba* contains colchicine and is highly poisonous; it was the national flower of Rhodesia. There are five species, found in tropical Africa and Asia.

Glossina morsitans *See* Glossinidae.

Glossinidae (tsetse fly; class Insecta, order Diptera, suborder Cyclorrapha) Family of flies which are well known as important carriers of disease organisms. The adults are moderate-sized flies, with aristae adorned with feathered hairs. The mouthparts are produced as a needle-like proboscis which is protected by a sheath when not in use to pierce host skin. The prosternum is membranaceous in the adult. Tsetse flies are carriers of the flagellate protozoon *Trypanosoma*, which causes sleeping sickness. Female tsetse flies feed on a wide range of animal blood, and produce mature larvae which develop within a 'uterus'. The deposited, full-grown larva buries itself in the ground and pupates. Different species of *Glossina* may carry

specific forms of *Trypanosoma* which vary in their virulence and periodicity. *G. morsitans* transmits forms that cause the disease nagana in domestic animals. Tsetse flies occur in Africa. Only 22 species have been described so far.

Glossodia (family Orchidaceae) Genus of terrestrial orchids with a single, hairy leaf which dies down each season, and an underground tuber which is replaced annually. The flowers are blue to purple, or white, and solitary or in pairs. The sepals and petals are more or less equal; the labellum is short and smooth. The fruit is a three-celled capsule containing many fine seeds. Several species are grown as pot plants. There are two species, both of them endemic to Australia, and found in the south and east of the country.

Glossopteris indica The Permian glacial deposits of S. Africa, Australia, S. America, and Antarctica are succeeded by beds containing a flora very different from that of N. America and Europe. The flora of the south grew in a cold, wet climate, while that of the north existed under warm conditions. Plants with elongate, tongue-shaped leaves dominated the southern flora, with the genera *Glossopteris* and *Gangamopteris* being among the best known. Of these two, the genus *Glossopteris* gives its name to the flora. *Glossopteris* is characterized by a leaf with a fairly well defined midrib and a reticulate venation. *G. indica* is the last species referred to the genus and the family Glossopteridales. It is known from the Trias of India.

glossy starling *See Aplonis*.

glowlight tetra (*Hemigrammus erythrozonus*) *See* Characidae.

glow-worm *See* Lampyridae.

glucagon Polypeptide hormone secreted by the alpha-cells of the Islets of Langerhans in the pancreas. By stimulating glycogenolysis (the breakdown of glycogen to glucose in the liver), it increases the level of glucose in the blood. Thus its function is antagonistic to insulin.

glucan (glucosan) Polysaccharide of glycosidically-linked glucose units. The types of linkage in a glucan chain may be mixed or may all be the same. Examples include cellulose, callose, and starch.

glucomannan *See* hemicellulose.

gluconeogenesis Synthesis of glucose from non-carbohydrate precursors. Any compound that can be converted into one of the intermediates of glycolysis is potentially glucogenic. These include amino acids, fatty acids, glycerol, and intermediates of the citric-acid cycle.

Gluconobacter (family Pseudomonadaceae) Genus of bacteria in which the ovoid or rod-shaped cells occur singly, in pairs, or in chains. They are aerobic chemo-organotrophs which can oxidize ethanol (ethyl alcohol) to acetic acid, and are found in soils and in plant materials, e.g. flowers, fruit, and products such as wine and cider. They can cause spoilage of alcoholic beverages.

glucosan *See* glucan.

glucose (dextrose, D-glucose) $C_6H_{12}O_6$. Aldohexose monosaccharide that is a major intermediate compound in cellular metabolism. *See also* glycogen.

glucoside A glycoside formed from glucose.

glume *See* Gramineae.

Gluta (family Anacardiaceae) Genus of trees, in which the leaves are simple. The bark has a highly irritant black sap which in some species yields a lacquer. There are 13 species, one of which occurs in Madagascar, the rest in Indo-Malaysia.

glutamic acid Dicarboxylic, polar amino acid.

glutamine Amino acid, the Y-amide of glutamic acid.

glutathione The tripeptide of glutamic acid, cysteine, and glycine, which is universally found in animal tissue. It functions as a coenzyme for some enzymes, e.g. for glyoxalase. Also it appears to act as an antioxidant, protecting the sulphydryl groups of certain enzymes and proteins.

gluten The principal protein in wheat.

glutton (wolverine, *Gulo gulo*) *See* Mustelidae.

glyceraldehyde Aldotriose sugar, a phosphorylated derivative of which is an important intermediate in the glycolytic pathway.

glyceride Ester formed from glycerol and between one and three fatty-acid molecules, respectively designated mono-, di-, or triglyceride. Glycerides serve variously as sources of energy, and triglycerides (lipids) also serve as thermal and mechanical insulators.

glycerol Three-carbon, linear, trihydroxy alcohol. Its fatty esters are a very important constituent of many lipids, and some of its phosphorylated derivatives are intermediates in glycolysis.

glycine The simplest alpha-amino acid, and the only one not to exhibit optical activity.

glycogen Highly branched homopolysaccharide composed of D-glucose units. It is the principal storage carbohydrate in animals. *See also* animal starch.

glycolate cycle Complex metabolic pathway, parts of which occur in the chloroplasts, mitochondria, and peroxisomes of plant cells. Its principal function is thought to be the formation of the amino acids serine and glycine from non-phosphorylated intermediates of the carbon-reduction cycle of photosynthesis.

glycolysis (Embden–Meyerhof pathway) The stepwise anaerobic degradation of glucose to produce as end-products either lactic acid (in cells of animals) or ethanol and carbon dioxide (in those of fungi and plants). One mole of glucose yields two moles of lactic acid (animals) or one mole each of ethanol and carbon dioxide (fungi and plants): in both cases the reaction sequence has a net yield of two moles of ATP. However, in most cells under aerobic conditions the pathway serves primarily to provide pyruvate, which is oxidized via the citric-acid cycle, and intermediate compounds for biosynthetic processes.

glycoprotein Conjugated protein consisting of a carbohydrate covalently linked to a protein. Included in this group are the mucins and mucoids.

glycoside Product obtained when a sugar reacts with an alcohol or phenol.

glyoxalase Enzyme that, in liver and muscle, catalyses the intramolecular oxidation–reduction of methylglyoxal to lactic acid.

glyoxysome Microbody that occurs only in microorganisms and plant cells that contain the enzymes of the glyoxylate cycle, whereby lipids are converted into sugars. *See also* peroxisome.

Glyptodontoidea (order Edentata, suborder Xenarthra) Extinct superfamily whose earliest representatives are known from the late Eocene and which flourished until the end of the Pleistocene in N. and S. America. Glyptodons were armadillo-like animals, all larger than modern armadillos and some later forms growing to a length of 2.7 m. The armoured plates tended to be fused into a solid carapace, forming a mosaic of small plates; the skull was covered by a bony casque; the tail was armour-plated, some forms bearing tail spikes; and most of the vertebrae were fused to form three sections, cervical, dorsal, and a final section comprising the latter dorsal, lumbar, and sacral vertebrae.

Glyptostrobus (swamp cypress; family Taxodiaceae) Genus of conifers, including *G. lineatus*, the Chinese swamp cypress, a deciduous conifer. The soft leaves are arranged in three ranks, and the cones are egg-shaped with shield-like scales. The trunk has a large basal buttress.

Gmelina (family Verbenaceae) Genus of trees which yield good timber. *G. arborea* is now extensively cultivated. There are 35 species, two occurring in Africa and the Mascarenes, the rest from Indo-Malaysia to Melanesia.

GMP (guanosine monophosphate) *See* guanosine phosphate.

gnatcatchers *See* Polioptilidae.

gnat eaters *See* Conophagidae.

gnathobase In some Arthropoda, an expanded process on the base segment of a limb, used for the manipulation of food.

Gnathobdellida (phylum Annelida, class Hirudinea) Order of aquatic or terrestrial, carnivorous, parasitic, or free-living, annelid worms in which a pharynx is present. All members of the order have three pairs of jaws. There are two families.

Gnathophiurina (brittle-stars; subclass Ophiuroidea, order Ophiurida) Suborder of brittle-stars in which the radial shield (one of several prominent, paired, oral ossicles of the dorsal surface) articulates with the genital plate by means of a ball-and-socket joint. The possible first occurrence of the suborder was in the Lower Jurassic, and it is known from the Cretaceous to Recent.

Gnathostomata 1 Superclass of jawed vertebrates, including the Pisces (fish), Amphibia, Reptilia, Aves (birds), and Mammalia. Recently it has been proposed that Gnathostomata should comprise the Elasmobranchiomorpha (sharks, rays, etc.) and the Teleostomi. The Teleostomi comprise the Osteichthyes, which in turn comprise the Actinopterygii (all living jawed fish except Dipnoi and the coelacanth), and the Sarcopterygii. This comprises the Actinistia (coelacanths), Dipnoi (lungfish), and Tetrapoda (terrestrial vertebrates). 2 (phylum Echinodermata, class Echinoidea) Superorder of echinoids, in which the periproct is outside the apical system, there are no compound ambulacral plates, a lantern and girdle are present, and the teeth are keeled. It includes the orders Holectypoida and Clypeasteroida.

gnatwrens *See* Polioptilidae.

gneiss General petrological term applied to banded rocks that formed during high-grade regional metamorphism. The banding is a result of the separation of dark minerals (e.g. biotite, hornblende, and pyroxenes) and light-coloured quartzofeldspathic minerals. A gneissose rock may be described more strictly by adding a qualifying prefix, e.g. biotite gneiss, hornblende gneiss, or pelitic gneiss.

Gnetales *See* Gnetopsida.

Gnetopsida Remarkable and probably artificial subdivision of the gymnosperms, comprising Gnetales only. There are three constituent genera, embracing trees, shrubs, and lianes (*Ephedra* and *Gnetum*), and even turnip-like plants (*Welwitschia*). Possible fossil material of the group is known from the early Permian, and there is also some fossil pollen from the Tertiary. With such a scant record it is not surprising that the evolutionary relationships of Gnetales remain unclear.

Gnetum Sole genus, with 30 species, of the pantropical gymnosperm family Gnetaceae, of which 28 species are woody climbers with gouty nodes, and 2 are trees. They are dioecious, and often cauliflorous. The seeds are naked, borne on racemes, and edible in many species, although some have irritant, hairy tissues.

gnotobiotic Applied to a culture in which the exact composition of organisms is unknown, usually during the formation of experimental laboratory ecosystems (microcosms) from axenic cultures.

goat (*Capra*) *See* Bovidae.

goatfish *See* Mullidae.

goat moth *See Cossus cossus*; and Cossidae.

goat tang Common name for the red seaweed *Polyides rotundus* (order Gigartinales). The plants are perennial; the thallus is cylindrical and filamentous, tough and cartilaginous, dull to dark red, dichotomously branched, and attached to a substrate by a discoid holdfast. It is found in rock pools in the lower intertidal region and below low-water mark.

go-away birds *See* Musophagidae.

Gobiesocidae (clingfish; class Osteichthyes, subclass Actinopterygii, order Gobiesociformes) Large family of small, marine, shallow-water fish,

recognizable by the powerful sucking disc formed by the pelvic fins placed ahead of the pectorals. They have a depressed head with a wide mouth and a rather flat, scaleless body. Many species, including *Lepadogaster candollei* (Connemara clingfish), 7 cm, are found close inshore among kelp beds, but some occur in fresh water. There are about 100 species, found worldwide.

Gobiesociformes Order of small, bottom-dwelling fish with a depressed head and scaleless body. The order includes Gobiesocidae (clingfish), Callionymidae (dragonets), and Draconettidae. According to some authors the Callionymidae and Draconettidae belong to the order Perciformes. *See also* Paracanthopterygii; and Xenopterygii.

Gobiidae (goby; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of marine coastal-water fish. Most species have the pelvic fins united to form a sucking disc which is used to cling to hard objects on the sea-floor. Unlike the clingfish (Gobiesocidae) the gobies have two dorsal fins, the first one being spiny. Gobies form an important part of the fish population of rocky shores, seagrass beds, and coral reefs. Some species live in close association with other animals, e.g. sea urchins and shrimps. Most gobies are very small; *Gobius vittatus* (striped goby) of the Mediterranean does not exceed 4 cm. One of the largest gobies is *G. giuris* of the Indo-Pacific, which reaches a length of 50 cm. With about 800 species, Gobiidae is the largest family of marine fish, found in tropical to temperate waters worldwide.

Gobioididae (eel gobies; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine or freshwater fish, which have an eel-like body, very small eyes, very long dorsal and anal fins, and a rounded tail-fin. The pelvic fins usually form an adhesive disc under the head. There are about 18 species, found in the tropical regions of the Indo-Pacific, America, and W. Africa.

Gobiomorus dormitor (bigmouth sleeper) *See* Eleotridae.

Gobius vittatus (striped goby) *See* Gobiidae.

goby *See* Gobiidae.

godwits *See Limosa*.

goethite Mineral, specific gravity 3.3–4.3, hardness 5.0–5.5, and with the chemical composition FeO(OH), named after the German writer J. W. von Goethe (1749–1832) who was also a mineral collector. It is a widespread iron mineral and is formed from the oxidation of other iron minerals, e.g. pyrite and magnetite. It occurs as a secondary mineral in the oxidized, or 'iron hat' zone of mineral veins, and can also replace minerals such as pyrite. It can be precipitated from marine waters to produce oolitic sedimentary iron ores, or from enclosed lagoons to form bog iron ore. It is distinguished by its colour, streak, and crystallinity which differs from that of limonite. It is usually very dark brown, but earthy forms are ochrous yellow-brown, with a brownish-yellow streak. The lustre can be adamantine, but is usually dull. It has an uneven fracture. The crystal system is orthorhombic: crystals are rare, but when they occur they are platy, bladed, and prismatic. Goethite usually occurs as massive, mammillated, botryoidal or stalactitic masses, with a fibrous, radiating structure.

golden algae *See* Chrysophyceae.

golden bat (*Myzopoda*) *See* Myzopodidae.

golden-brown algae *See* Chrysophyceae.

golden eagle (*Aquila chrysaetos*) *See Aquila*.

golden hamster (*Mesocricetus auratus*) *See* Cricetidae.

golden larch *See Pseudolarix*.

golden mole *See* Chrysochloridae.

golden oriole (*Oriolus oriolus*) *See Oriolus*.

golden-ringed dragonfly (*Cordulegaster boltonii*) *See* Cordulegasteridae.

golden rod *See Solidago*.

golden-yellow algae *See* Chrysophyceae.

goldfinch (*Carduelis carduelis*) *See Carduelis*.

goldfish (*Carassius auratus*) *See* Cyprinidae.

goldspotted spinefoot (*Siganus chrysospilos*) *See* Siganidae.

Golgi body System of flattened, smooth-surfaced, membranaceous cisternae arranged in parallel 20–30 nm apart, and surrounded by numerous vesicles. A feature of almost all eukaryotic cells, this structure is involved in the packaging of many products of cell metabolism.

Goliath beetle (*Goliathus giganteus*) *See* Scarabaeidae.

Goliathus giganteus (Goliath beetle) *See* Scarabaeidae.

Gomphidae (dragonflies; order Odonata, suborder Anisoptera) Cosmopolitan family of swift-flying, slender dragonflies, which usually alight near running water. They can be distinguished from members of other anisopteran families by having similar triangles in the fore- and hindwings, an ill-defined anal loop in the hindwing, and eyes which are far apart. The nymphs are bottom-dwellers in streams, often burrowing in mud. Some possess respiratory tubes. More than 870 extant species have been described. *See also* venation.

Gomphotheriidae (order Proboscidea, suborder Gomphotherioidea) Extinct family of mastodons, characterized by the development of multiple accessory tooth cusps and believed to be ancestral to the later mastodons, though not to modern elephants. These long-jawed mastodons or gomphotheres were one of three distinct proboscidean lines established by the Miocene. They in turn diverged into a variety of descendent lines, several of which had highly specialized lower jaws. The family persisted into the Pleistocene in both Old and New Worlds. Long snouts appeared in the earliest forms and in the Miocene *Gomphotherium* the lower jaw and premaxilla were very long, both

bearing tusks which may have been used for digging, and probably permitting only a short trunk. In later forms the face became shorter and the trunk presumably became longer. There were many genera and species. The evolutionary importance of the gomphotheres lies in the probable parallel between their development and that of the line which led to the true elephants.

gonadotropin Generic term for a group of hormones secreted by the posterior lobe of the pituitary, the placenta, and the endometrium that stimulates the gonads.

gonangulum *See* Lepismatoidea.

Gondwana Former supercontinent of the southern hemisphere from which S. America, Africa, India, Australia, and Antarctica are derived. Their earlier connection explains why related groups of plants and animals are found in more than one of the now widely separated southern land masses; examples include the Dipnoi (lungfish) common to S. America, Africa, and Australia, and the monkey-puzzle tree (*Araucaria*) common to S. America and Australia.

gongylidia *See* Attini.

Goniactinida (class Stelleroidea, subclass Somasteroidea) Order of extinct asterozoans, which possess shallow ambulacral grooves. The tube-feet are positioned in large, basin-like depressions in the ambulacral plates and may not always have passage to the coelomic cavity. Each ambulacral ossicle gives rise to a laterally positioned row of ossicles (virgals) called metapinnules.

goniatites *See* Ammonoidea.

gonidia *See* Leucotrichaceae.

gonococcus *Neisseria gonorrhoeae*, the causal agent of gonorrhoea.

gonopodium Intromittent copulatory organ formed by a modified anal fin and present in adult male fish of the family Poeciliidae (live bearers).

gonopore An external opening of a reproductive system. *See also* Malacostraca.

gonorrhoea Sexually-transmitted disease of humans, caused by *Neisseria gonorrhoeae*. In the male, symptoms begin with urethral discharge and painful urination; in the female early symptoms are mild or lacking. If untreated, systemic involvement may occur and sterility may result.

Gonorynchidae (sandfish; class Osteichthyes, subclass Actinopterygii, order Gonorynchiformes) Family of marine fish which have an almost pencil-shaped, round body. The sandfish is recognizable by the single, backward-placed dorsal fin opposite the ventral fins, with the anal fin even closer to the tail-fin. The small mouth is somewhat below the pointed snout. *Gonorynchus greyi* (sandfish), found all around Australia, reaches a length of 40 cm and lives in shallow to deep water; its flesh is of good flavour. There are one or two species, found in the Indo-Pacific region.

Gonorynchiformes Order of marine fish, which have a small mouth, and toothless jaws. The single dorsal fin and the ventral fins are located half-way down the body, or further backward. The four families include Gonorynchidae (sandfish) and Chanidae (milkfish).

Gonorynchus greyi (sandfish) *See* Gonorynchidae.

Gonostomatidae (bristlemouth; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of deep-sea fish, which have an elongate body, a large mouth, and a single dorsal and a long anal fin. The pectoral and pelvic fins are small. A series of light organs is often present along the belly side of the fish. Although the bristlemouth is a small fish (7 cm), many species, e.g. *Cyclothone braueri* and *C. pallida*, seem to be present in large numbers in the deep sea. There are about 60 species.

gonotheca In some colonial Coelenterata, a cylindrical capsule containing a reproductive polyp.

gonozooid In some colonial Coelenterata, a reproductive polyp.

Gonyaulax (class Dinophycaeae) Genus of dinoflagellates, species of which are responsible for the phenomenon known as 'red tide'. Species are capable of emitting light, and are a common cause of bioluminescence in the sea.

Gonystylus (family Thymelaeaceae) Genus of trees whose bark contains silky, irritant fibres. The leaves are gland-dotted. The flowers have five sepals, no petals, a disc, many stamens, and a superior ovary. The fruit is a capsule; the seeds arillate. The trees yield a pale, useful timber. *G. bancanus* provides ramin, much used for mouldings. There are 16 species, found in rain forests of the permanently wet parts of Asia and the Pacific, from Malesia to the Solomons and Fiji.

Goodeidae (goodeid topminnow; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Family of freshwater fish, including deep-bodied as well as elongate species, which have a single dorsal fin opposite the anal fin, and a fairly pointed snout. Like the other species, *Goodea gracilis* (9 cm) is a live-bearer; the males have a modified anal fin which can act as a primitive gonopodium. There are about 34 species, found in W. Mexico.

goodeid topminnow *See* Goodeidae.

Goodenia (family Goodeniaceae) Genus of small herbs, or upright or scrambling shrubs, which have alternate or radical leaves. The flowers are held in terminal spikes or racemes, and are usually yellow, white, or purple. The calyx is lobed, and the sepals are united at the base but split open on one side only. The five petals are fused at the base, often winged, and arranged in two lips with three lobes on the lower and two on the upper. The stigma has a cup-shaped cover with stiff hairs around the lip. The five stamens are free. The fruit is a small two-celled capsule containing the flat seeds. There are 120 species, all endemic to Australia, and one additional species found in Malaysia. Many species are xerophytic.

Goodeniaceae Family of shrubs and herbs, in which the flowers are zygomorphic. The corolla

tube is split almost to its base, with a lobed limb. The style has an outgrowth surrounding the stigma. The ovary is inferior. There are 14 genera, with 300 species: they are mainly confined to Australia, but a few occur on tropical coasts.

goose *See* geese.

goose barnacles *See Lepas anatifera*; and Lepadidae.

gooseberry (*Ribes uva-crispa*) *See* Grossulariaceae; and *Ribes*.

goosefish (*Lophius americanus*) *See* Lophiidae.

goosefoot *See* Chenopodiaceae.

goosegrass (cleavers, *Galium aparine*) *See Galium*.

gopher tortoise *See Gopherus polyphemus*.

Gopherus polyphemus (gopher tortoise; order Chelonia (Testudines), suborder Cryptodira, family Testudinidae) Species of tortoises, which excavate long tunnels to avoid extreme heat, emerging at dusk to feed. Males have elongated anterior plates on the carapace, used to lever rival males on to their backs when competing for a mate. The species occurs in the deserts and prairies of the southern USA.

Gorgonacea (sea fans; subclass Octocorallia) Order of colonial octocorals, anchored by a holdfast, and having a tree-like shape supported by a branching, central skeleton of horny (gorgonin) or calcareous material, or both. They appeared first in the Cretaceous. The order contains two suborders, 18 families, and about 120 genera.

gorilla (*Gorilla gorilla*) *See* Pongidae.

goscojales *See* Mediterranean scrub.

goshawks *See Accipiter*.

Gossypium (family Malvaceae) Genus of shrubs or small trees whose fruit is a brittle capsule. The seeds are hairy, providing cotton from several species (e.g. in America *G. barbadense* and *G. hirsutum*; and from Africa to India *G. arboreum* and *G. herbaceum*). There are 30 species, found in the tropics and subtropics.

gourami *See* Belontiidae.

gourami, giant *See* Osphronemidae.

gourd (*Cucurbita pepo*) *See* Cucurbitaceae.

GPP (gross primary productivity) *See* primary productivity.

Graafian follicle Fluid-filled spherical vesicle in the ovary of a mammal, containing an oocyte attached to its wall, and responsible for oestrogen production in the ovary. A cavity first appears amongst follicle cells surrounding the oocyte, around the end of the period of cytoplasmic growth of the oocyte. In mammals with an oestrous cycle, it enlarges during the early part of the cycle, so that follicle cells separate into two layers, one around the oocyte and the other an external layer, until the follicle bursts on to the surface of the ovary, discharging the oocyte (ovulation). Most follicles, however, will not ovulate but will simply degenerate; the rest form the corpus luteum in most mammals. Follicle growth is under the influence of the pituitary gland.

graben Structural feature caused by the relative lowering of a block between two faults or fault zones. The faults are commonly high-angle, normal faults which are parallel in their strike direction, thereby producing an elongated trough which may be of considerable length. *Compare* horst; *see* rift zone.

Gracilariaceae (order Gigartinales) Family of red seaweeds in which the thallus is cylindrical, strap-like, or broadly lobed. *Gracilaria* is the only British genus; the thallus is dark purplish-red, cylindrical, and irregularly branched, with a discoid holdfast. It is found attached to rocks at and below low-water mark.

Gracillariidae (order Lepidoptera) Widespread family of very small moths, with narrow, strongly fringed, colourful wings. At rest the anterior part of the body is generally raised. Larvae are leaf-miners for all or part of their lives. Pupation occurs within the mine or in a chamber formed when the larva rolls the edge of the leaf.

gradate sorus Type of sorus (or group of sporangia) in ferns (e.g. in Hymenophyllaceae), in which there is a sequence of development of ripe sporangia from apex to base of the sorus This contrasts with the simple sorus (e.g. in Osmundaceae) in which there is simultaneous ripening of all the sporangia, which is regarded as primitive; or with the mixed sorus (e.g. in Polypodiaceae) in which there is irregular ripening of later sporangia among earlier ones, which is regarded as advanced.

grade 1 Group of things all of which have the same value. 2 (geomorph.) Balanced condition of a river when it has just sufficient energy to transport the load supplied from the drainage basin; a balance between erosion and deposition. The concept has also been applied to hillslopes that are stable dynamically and so maintain themselves in the most economical configuration. The term is no longer used widely as it oversimplifies the issues involved. 3 (evol.) Distinctive functional or structural improvement in the organization of an organism. Thus fish, amphibians, reptiles, and mammals represent successive vertebrate grades. Grades may occur within a single lineage; or the same grade may be achieved independently in different ones (e.g. warm-bloodedness evolved independently in birds and mammals).

graded bedding Sedimentary structure in which there is an upward gradation from coarser to finer material, caused by the deposition of a heterogeneous suspension of particles. The feature may be used to establish the 'way up' or natural succession of strata.

gradient In meteorology, the rate of change of a function (e.g. pressure or temperature), at right angles to the isolines.

gradient analysis Ordination technique for the description of vegetation based on characteristics of the site rather than the composition of species. One or more environmental gradients are identified and stands are arranged in order along them according to the characteristics of their sites. The vegetation is then examined to discover any related pattern.

gradient wind The wind that represents the balance among all the forces acting upon moving air. It may be expressed by V in the equation: $G = 2D\omega V \sin \phi \pm DV^2/r + F$, where G is the pressure gradient, D the air's density, ω the angular velocity of the Earth's rotation about its axis, ϕ the latitude, r the radius of curvature of the air's path, F the friction, and V the air's velocity when the forces are in balance. The sign before the second term is + when the motion is around a cyclonic (low-pressure) centre, − when the motion is around an anticyclonic (high-pressure) centre. *See also* geostrophic wind.

gradualism *See* phyletic gradualism.

graft 1 (noun) Small piece of plant or animal tissue implanted into an intact organism. 2 (verb) Transfer a part of an organism from its normal position to another position on the same organism (autograft), or to a different organism of the same species (homograft), or an organism of a different species (heterograft). The source of the part that is grafted is called the donor (in animals) or the scion (in plants), and the organism to which it is united is called the host or recipient (in animals) or stock (in plants). A graft hybrid is an organism made up of two genetically distinct tissues due to fusion of host and donor (or scion and stock) after grafting. In cultivation, a stem from one plant (the scion) is fused with a rooted portion of another (the stock) to form a single plant. Most fruit trees are produced by grafting, the type of fruit being determined by the scion, but the size of the tree by the stock.

grain weevil (*Sitophilus granarius*) *See* Curculionidae.

Grallaria (antpittas; family Formicariidae) Genus of small, brown, long-legged, short-tailed birds, which inhabit thick forest. They are mainly terrestrial and insectivorous, feeding particularly on ants. They nest on the ground. There are 22 species, found in C. and S. America.

Grallinidae (magpie larks, mudnest builders; order Passeriformes) Family of black and white or grey birds with varied features, the mudnest builders often separated into a separate family, Corcoracidae. They inhabit forest, woodland, and scrub, and build mud nests stuck to a horizontal branch. There are three genera, with four species, found in Australia and New Guinea.

Gramineae The grass family; a very large and important family of monocotyledons, mostly annual or perennial herbs, but in a few genera (e.g. the bamboos) woody. From an ecological viewpoint, it is the most successful family of flowering plants: where forests have been destroyed by humans, grasses have tended to replace the trees as the dominant vegetation of many areas of the world. Economically the Gramineae is the family of plants most important to humans, as it contains numerous cereal grasses, e.g. wheat, barley, oats, maize, rice, and millet, the staple foods of most of the world's population. Many grasses are important sources of fibres. Most grasses have hollow stems with solid points (nodes) capable of intercalary growth, and leaves in two opposite and alternating rows. Each leaf consists of a sheath round the stem, a blade, and usually a flap or ligule at the junction of sheath and blade. Inflorescences are very varied but are usually composed of units (spikelets) with a pair of sterile glumes at the base of each spikelet. Each spikelet consists of one to many florets, each floret normally having two subtending scales (the lower chaffy lemma and the upper membranaceous palea), three stamens with long filaments and flexible anthers (adapted to wind-pollination), and an ovary with one ovule and two long, feathery stigmas. There are about 600 genera, with perhaps 10 000 species, distributed throughout the world.

Gramma loreto (basslet) *See* Grammidae.

Grammatophyllum (family Orchidaceae) Genus of plants, several of which are giant, leafy herbs, including *G. speciosum*, the biggest orchid plant in the world, which has stout stems up to 2 m long and big, paniculate inflorescences. There are 10 species, occurring from Malaysia to the Pacific islands.

Grammicolepididae (class Osteichthyes, subclass Actinopterygii, order Zeiformes) Family of marine, deep-sea fish somewhat similar to dories, but which have a small, nearly vertical mouth, and long scales arranged in almost vertical rows across the body. They are rather rare fish; one species, *Vesposus egregius*, is based on a specimen brought up by a lava flow near Hawaii. They are widely distributed.

Grammidae (basslets; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of tropical marine fish which have two dorsal fins, thoracic pelvic fins, and an interrupted or absent lateral line. *Gramma loreto* (basslet), 8 cm, is sometimes used as an aquarium fish. There are about nine species, occurring in the Indo-Pacific region and the W. Atlantic.

Grammistes sexlineatus (six-lined perch) *See* Grammistidae.

Grammistidae (soapfish, six-lined perch; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, deep-bodied fish in which the two dorsal fins, as well as the other fins, have a rounded profile. Typically, members of the family are able when disturbed to release a thick mucus, which turns into a soapy froth. *Grammistes sexlineatus* (six-lined perch) and a few other species are attractively coloured. This species lives among coral reefs, reaching a length of 25 cm. There are about 17 species, occurring in the Indo-Pacific and Atlantic.

Gram-negative bacteria *See* Gram-reaction.

Gram-positive bacteria *See* Gram-reaction.

Gram-reaction Reaction obtained when bacteria are subjected, in the laboratory, to a certain staining procedure called the Gram stain or Gram's stain (after the Danish scientist Christian Gram). The bacteria are killed, and stained for example with crystal violet; the stained cells are then treated with acetone or ethanol, for instance. Bacteria fall into two categories: those that are readily decolorized under these conditions, and those that retain the stain. Cells of the former type are said to be

Gram-negative; those of the latter type are said to be Gram-positive. The difference in reaction reflects a fundamental difference in the structure of the cell wall in the two types of bacteria.

Gram's stains Stains used in the Gram-reaction for the differential staining of bacteria. Used sequentially they are (a) methyl violet, (b) Gram's iodine, and (c) safranin or basic fuchsin.

grandillas *See* Passifloraceae.

granite Petrological name given to a medium- or coarse-grained, acid, igneous rock of plutonic origin containing at least 20% w/v quartz, orthoclase (potassium feldspar), sodium feldspar, and a small proportion of a mafic material. The term is also applied in a more general way to describe a range of acid, igneous rocks of plutonic origin.

granite moss Common name for a moss of the subclass Andreaeidae, usually found on hard siliceous rocks in mountainous regions.

granular *See* texture.

granulocyte (polymorph) *See* leucocyte.

granulose Consisting of or covered with small granules or grains.

Granulosina (starfish; subclass Asteroidea, order Valvatida) Suborder of starfish which have a stout frame of a few marginal ossicles arranged in opposing upper and lower rows. The outer surfaces of the ossicles are covered with short, granular spines. The suborder first appeared in the Jurassic and persists to the present day.

granulosis Disease of insects caused by certain DNA-containing viruses. The name of the disease derives from the granular inclusions seen in the cells of an infected insect. It affects mainly the larval stages of members of the Lepidoptera.

granum Part of the internal structure of a chloroplast, consisting of 5–30 membranaceous discs or thylakoids, 0.25–0.8 μm in diameter. There may be 40–80 grana in a typical chloroplast.

Granville wilt Disease of tobacco plants, caused by the bacterium *Pseudomonas solanacearum*. Symptoms include wilting and yellowing of the leaves.

grapefruit (*Citrus paradisi*) *See Citrus*.

Graphidaceae (order Graphidales) Family of lichens in which the thallus is crustose and the apothecia are lirelliform (elongated and slit-like). There are 12 genera, found chiefly on bark in warmer regions.

Graphis (family Graphidaceae) Genus of crustose lichens in which the apothecia are typically black, elongated, and slit-like. The spores are colourless, elongated, and multiseptate. There are many species, of which only two occur in Britain. They are found on trees.

graptolites *See* Graptolithina.

Graptolithina (graptolites; phylum Hemichordata, subphylum Stomochordata) Class of extinct, colonial, marine organisms which secreted a chitinous exoskeleton with characteristic growth bands and lines. Each individual polyp or zooid of the colony lived in a tube (theca), thecae usually overlapping in a single or double row along branches (stipes). One or more stipes originated from a small conical cup (sicula). The complete skeleton (colony) is referred to as a rhabdosome. They were mainly epiplanktonic, some sessile and attached by a nema (thread) originating from the apex of the sicula. They first appeared in the Middle Cambrian and are last known from the Lower Carboniferous. The class comprises two orders: true graptolites (Graptoloidea), which are important zonal fossils in Ordovician and Silurian rocks; and the dendroid graptolites (Dendroidea).

Graptoloidea (graptoloid graptolites; class Graptolithina) The most widespread and abundant order of graptolites, which were planktonic or epiplanktonic. Only one type of theca (the autotheca) is present. A rhabdosome is formed usually from a few stipes whose orientation relative to the sicula is very variable. Graptoloidea are abundant from black shales of Lower Ordovician to Lower Devonian age, and are widely used for zoning.

graptoloid graptolites *See* Graptoloidea.

grass *See* Gramineae.

grass carp (*Ctenopharyngodon idella*) *See* herbivorous fish.

grass-cutters *See* Thyronomyidae.

grass flies *See* Chloropidae.

grass heath *See* acidic grassland.

grasshoppers *See* Acrididae; Caelifera; Ensifera; Eumastacidae; Gryllacrididae; locust; Orthoptera; Pneumoridae; Proscopiidae; Pyrgomorphidae; Tettigoniidae; and Tetrigidae.

grasshopper warblers *See Locustella*.

grassland Vegetation dominated by grasses. Grassland occurs where there is sufficient moisture for grass growth, but where the environmental conditions, both climatic and anthropogenic, prevent tree growth. The extensive mid-latitude grassland is known as steppe or prairie, whereas the corresponding tropical vegetation is called savannah.

grass minimum temperature Minimum temperature recorded in open ground at night by a thermometer whose bulb is exposed over the tips of short grass.

grass snake *See Natrix natrix*.

grass spiders (*Agelena*) *See* Agelenidae.

grass-trees *See Xanthorrhoea*; and Xanthorrhoeaceae.

gravitational water Water that moves through soil under the influence of gravity and that must be removed from the soil before this can attain field capacity.

gravity tectonics (gliding tectonics) Mechanism whereby large masses of rocks move down a slope under gravitational force, producing folding and faulting of varying extent and complexity.

grayling butterflies *See* Satyrinae.

graywacke *See* greywacke.

grazing pathway (grazing food-chain) Food-chain in which the primary producers (green plants) are eaten by grazing herbivores, with subsequent energy transfer to various levels of carnivore. *Compare* detrital pathway.

great auk (*Pinguinus impennis*) *See* Alcidae.

great blue heron (*Ardea herodias*) *See Ardea*.

great crested newt *See Triturus cristatus*

greater roadrunner (*Geococcyx californianus*) *See* Cuculidae.

greater weeverfish (*Trachinus draco*) *See* Trachinidae.

great house gecko *See Gekko gecko*.

great silver diving beetle (*Hydrophilus piceus*) *See* Hydrophilidae.

great spotted cuckoo (*Clamator glandarius*) *See Clamator*.

great stag beetle (*Lucanus cervus*) *See* Lucanidae.

grebes *See Podiceps*; and Podicipedidae.

Greek moray (*Muraena helena*) *See* Muraenidae.

Greek tortoise *See Testudo hermanni*.

green algae Common name for algae of the class Chlorophyceae; not all members are green, e.g. members of the Trentepohliaceae are typically orange.

greenbottles *See* Calliphoridae.

greenbuls *See* Pycnonotidae.

green crab *See Carcinus maenas*.

greeneye *See* Chlorophthalmidae.

greenfinch (*Carduelis chloris*) *See Carduelis*.

greenfly *See* Aphididae.

greengage *See Prunus*.

greenhead *See* Tabanidae.

greenheart (*Ocotea rodiaei*) *See Ocotea*.

'greenhouse effect' The effect of heat retention in the lower atmosphere as a result of absorption and reradiation of long-wave (more than 4 μm) terrestrial radiation by clouds and gases, e.g. water vapour and carbon dioxide. The insulating effect is analogous to that of greenhouse glass, and alters the balance of incoming and outgoing radiation in the Earth's energy budget. Marked increases in atmospheric carbon dioxide, generated for example by the combustion of fossil fuels, could result in a global increase of atmospheric temperatures if not offset by other (perhaps natural) changes. *See also* atmospheric window.

green iguana *See Iguana iguana*.

green knifefish (*Eigenmannia virescens*) *See* Rhamphichthyidae.

green lacewings *See* Chrysopidae.

Greenland halibut (*Reinhardtius hippoglossoides*) *See* Pleuronectidae.

Greenland shark (*Somniosus microcephalus*) *See* Squalidae.

greenling *See* Hexagrammidae.

green lizard *See Lacerta viridis*.

green mint beetle (*Chrysolina menthastri*) *See* Chrysomelidae.

green monkey fever Disease of humans, originally contracted by individuals handling tissue from African green monkeys (*Cercopithecus aethiops*). Symptoms begin suddenly and include fever, pains in head and limbs, intestinal disturbances, and a confused mental state; cardiac and renal failure may follow. The mortality rate is high. It is caused by a virus known as the Marburg agent.

green oak Oakwood stained bluish-green as a result of infection with the fungus *Chlorosplenium aeruginascens*. The wood is highly prized for inlay work in furniture-making, etc.

green oriental emerald *See* corundum.

green pepper *See Capsicum*.

green pigeons *See Treron*.

greensand Term applied to glauconite-rich sandstones and calcareous sandstones. The Lower and Upper Greensands of SE England occur beneath and above the Gault.

green sawfish (*Pristis zijsron*) *See* Pristidae.

greenschist Schistose metamorphic rock consisting of the minerals sericite, epidote, chlorite, and albite. The greenschist facies is the lowest grade of Barrovian-type regional metamorphism, although not all rock compositions produce greenschists in this facies.

greenstone belt Large geological formation, up to 250 km across, that is largely of Archaean age. Greenstone belts are considered to represent ancient volcano-sedimentary basins bordered and intruded by granitic plutons. These formations represent an important phase of crustal evolution and currently it is considered that they are remnants of back-arc basins.

green sulphur bacteria *See* Chlorobiaceae.

green swordtail (*Xiphophorus helleri*) *See* Poeciliidae.

green toad *See Bufo viridis*.

green tree frog *See Hyla arborea*.

green turtle *See Chelonia mydas*.

gregaria *See* locust.

Gregarinia (class Telosporea) Subclass of protozoa which live parasitically in the digestive tracts of invertebrates, apparently causing little harm to their hosts. The life cycle can be completed in a single host species.

gregariousness Tendency of animals to form groups which possess a social organization. *Compare* aggregation.

grenadier *See* Macrouridae.

Grenz horizon *See* sub-Atlantic.

Grevillea (family Proteaceae) Genus of trees and shrubs, which includes *G. robusta* (silky oak), widely cultivated in the tropics as a shade tree and for its useful timber. There are 190 species, occurring in E. Malesia, the W. Pacific islands, and Australia.

grex Slug-like pseudoplasmodium formed by cellular slime moulds of the order Dictyosteliales.

greybirds *See Coracina*.

grey-brown podzolic Soil-profile term describing eluviated, freely draining soils that have a distinctive clay-enriched B horizon. The term is obsolete under the US Soil Taxonomy. *See also* Alfisols.

greylag goose (*Anser anser*) *See Anser*.

grey large-eye bream (*Gymnocranius griseus*) *See* Pentapodidae.

grey mould Common and widespread disease of plants, caused by the fungus *Botrytis cinerea*. A fluffy grey mould appears on flowers, leaves, or fruit. Infection is encouraged by poor ventilation, which produces conditions of still air and high humidity.

grey mullet *See* Mugilidae.

grey nurse shark (*Odontaspis taurus*) *See* Odontaspididae.

grey partridge (*Perdix perdix*) *See Perdix*.

grey phalarope *See* polyandry.

greywacke (graywacke) Texturally and mineralogically immature sandstones that contain more than 15% clay minerals. They may consist of angular to sub-rounded grains of quartz and feldspar, small pebbles, and a fine matrix of clay minerals, chlorite, and carbonate.

grey whale (*Eschrichtius*) *See* Eschrichtiidae.

grid analysis of pattern The detection of pattern using a contiguous grid of quadrats, rather than random sampling with a given quadrat size. By blocking adjacent quadrats in pairs, fours, eights, etc., the data may be analysed using increasingly larger quadrat sizes. This is important since the detection of pattern relates to the quadrat size used, with the most marked demonstration of contagion occurring when the quadrat size is approximately equal to the clump area (i.e. the size of the clumps). When the presence of contagion is not immediately obvious, detection of the scale of non-randomness (i.e. the quadrat size at which it is evident) provides very useful information as it may suggest the likely cause of the clumping.

Grifola (order Polyporaceae) Genus of fungi, in which the fruit body consists of a branched stem, each branch ending in a flattened, fan-like pileus. In *G. frondosa* the tuft of pilei may reach 40 cm across; each pileus measures 4–10 cm across, is leathery in texture, and typically has a greyish and wrinkled upper surface. The pores on the under-side are whitish and extend down the stem. This species has a distinctive odour of mice (acetamide). It is parasitic on trees, especially oak, and grows at the base of the trunk.

grike Deep, tapering cleft, normally a solution-widened joint, cut into the surface of a near-level area of hard limestone. In NW Yorkshire, England, it may be 15–60 cm wide at the surface and commonly 0.5–3 m deep. The deepest grikes are developed where several joints intersect, and may develop into shallow caves.

Grimmia (order Grimmiales) Genus of mosses in which the stems are short and dichotomously branched, usually forming dense cushions. The leaves typically end in a fine, silvery hair-point, giving the cushions a hoary appearance. It is a cosmopolitan genus of about 170 species; almost entirely saxicolous. *G. pulvinata* forms hemispherical cushions on walls and roofs throughout lowland Britain. The capsules are borne on setae, which are initially strongly curved, but later straighten.

Grimmiales (subclass Bryidae) Order of (mainly) acrocarpous mosses of medium size; mostly tufted, or cushion-forming. The leaves often terminate in long, fine 'hair-points'. They are mostly saxicolous. Genera include *Grimmia*, *Racomitrium*, and *Schistidium*. *S. maritimum* and *S. apocarpum* were formerly known as *Grimmia maritima* and *Grimmia apocarpa*, respectively. *S. maritimum* is found only on rocks by the sea; *S. apocarpum* is common on rocks and walls, often in association with *G. pulvinata* and *Tortula muralis*.

grinner *See* Synodontidae.

grisette Common name for the edible fruit body of *Amanita vaginata* (common grisette) or *A. fulva* (tawny grisette). Both species are common on the ground beneath broad-leaved trees in late summer and autumn.

Gromphadorhina *See* Blaberidae.

grooming Behaviour concerned with the care of the body surface, performed by an animal upon itself (autogrooming), or by one animal upon another of the same species (allogrooming). In some animals (e.g. rodents) the spreading of saliva on the fur during grooming may serve a role in thermoregulation. Autogrooming may serve to change the state of arousal of an animal; allogrooming strengthens social bonds and helps to provide all members of a group with a scent characteristic of the group, by means of which group members may identify one another.

grosbeaks *See* Cardinalidae; Fringillidae; and *Pheucticus*.

gross ecological efficiency *See* food-chain efficiency.

gross primary productivity (GPP) *See* primary productivity.

Grossulariaceae Family of shrubs with alternate, simple, often palmately lobed leaves; and regular, tetra- or pentamerous flowers in racemes, with the same number of stamens as petals. The ovary is inferior, consisting of two fused carpels, forming a berry in the fruit. There is one genus, *Ribes*, and about 150 species in the northern temperate zone, and in mountains of C. and S. America. The genus

contains several important cultivated fruit-producing species, especially *R. nigrum* (black currant), *R. sylvestre* (red currant), and *R. uva-crispa* (gooseberry); other species are cultivated for their flowers.

ground beetle *See* Carabidae.

ground cricket *See* Gryllidae.

ground doves *See Columbina*.

ground flora General term describing plants of the field and ground layers.

ground frost Condition in which the ground surface has a temperature below 0 °C.

groundhopper *See* Tetrigidae.

ground layer Lowermost layer of a plant community, comprising especially mosses, lichens, and fungi, together with low-growing herb species which often have trailing stems or rosette forms.

groundmass Interstitial material lying between coarser crystals (phenocrysts) in an igneous rock.

groundnut (*Arachis hypogaea*) *See Arachis*.

groundroller *See* Brachypteraciidae.

groundsel (*Senecio*) *See* Compositae.

ground sloth *See* Megalonychoidea.

ground substance Amorphous, transparent, extracellular organic material found in connective tissue, which acts as a matrix within which a variety of fibres and cells are embedded. Most of it consists of acidic polysaccharides bound to proteins that endow it with substantial mechanical properties. These same properties also allow it to act as a barrier to bacterial infections.

ground water Water that occurs below the Earth's surface, contained in pore spaces within regolith and bedrock. It is either passing through or standing in the soil and underlying strata, and is free to move under the influence of gravity. *See also* vadose.

grouper *See* Serranidae.

group selection Theory that holds that some kinds of behaviour (e.g. in certain species the decline in reproductive rates of a population that has passed the optimal density) are due to group selection, which works to the advantage of populations rather than individuals. There is general scepticism about this theory.

group translocation Mechanism widely utilized for the transportation of sugars across bacterial membranes and perhaps those of some higher cells. A donor compound is used to activate sugar molecules through the provision of a high-energy phosphate group. The activated sugar can thus more readily traverse the membrane. A number of membrane proteins have been implicated in the transfer process.

grouse *See Lagopus*; and Tetraonidae.

grouse locust *See* Tetrigidae.

grove 1 Small wood, usually of less than eight hectares. 2 Area composed entirely of timber trees (without underwood) within a larger woodland which contains underwood.

growan *See* saprolite.

growing season In seasonal climates, the period of rapid growth. Various definitions are used. In Britain, the growing season is the period when the mean temperature exceeds 6 °C, though there is no agreement whether daily, weekly, or monthly means should be used, or whether these should be of ground or air temperatures. In the USA, the growing season is defined as the period between the last killing frost of spring and the first killing frost of autumn, a killing frost usually being regarded as one recorded on a thermometer exposed in a standard way in a Stevenson's screen.

growth Irreversible increase in size of a cell, organ, or organism. This may occur by cell enlargement or by cell division.

growth form 1 Morphology of a plant or animal, especially as it reflects physiological adaptation to the environment. *See also* life-form. 2 Shape of population growth, as expressed by a growth curve (e.g. J-shaped, S-shaped).

growth hormone (somatotropin) Proteinaceous hormone secreted by the anterior lobe of the pituitary (the adenohypophysis), which promotes growth of the body and has a stimulatory effect on many aspects of metabolism.

growth regulator Synthetic compound that, when applied to a plant, promotes, inhibits, or otherwise modifies the growth of that plant.

growth retardant One of a group of synthetic compounds that reduce stem elongation in plants by inhibiting the activity of the subapical meristem. An important agricultural use is in the prevention of lodging in cereals. In horticulture retardants are used to give more compact plants. Some of these compounds inhibit gibberellin synthesis.

growth substance Naturally occurring compound, other than a nutrient, that promotes, inhibits, or otherwise modifies the growth of a plant.

grubfish *See* Mugiloididae.

Gruidae (cranes; order Gruiformes) Family of large, long-legged, long-necked, white, grey, or brown birds. The head has areas of bare red skin or plumes; the bill is straight, and medium to long. Secondaries are elongated for display; the tail is short; and the wings are broad for soaring and gliding, the birds flying with the neck extended. Cranes inhabit plains and marshes, feed on animal and vegetable matter, and nest on the ground. There are four genera, with 14–15 species, many of which are endangered. They are found in N. America, Europe, Asia, Africa, and Australasia. The northern species are migratory.

Gruiformes (cranes, rails, bustards; class Aves) Diverse order of small to large aquatic and terrestrial birds. There are 12 families: Aramidae, Cariamidae, Eurypygidae, Gruidae, Heliornithidae,

Mesitornithidae, Otididae, Pedionomidae, Psophiidae, Rallidae, Rhynochetidae, and Turnicidae. They are found worldwide.

grunt 1 *See* Pomadasyidae. 2 *See* Theraponidae.

grunting thorny catfish (*Amblydoras hancocki*) *See* Doradidae.

Grus (cranes; family Gruidae) Genus of grey or white, long-legged, long-necked birds which have prominent red areas of skin on the head or face. *G. grus* (common crane) is found across Europe to E. Asia, wintering in Africa and S. Asia. Cranes feed on insects, mammals, small birds, and some vegetable matter. There are 10 species found, in Europe, Asia, N. Africa, N. America, Australia, and New Guinea.

grus *See* saprolite.

Grus grus (common crane) *See Grus*.

Gryllacrididae (class Insecta, order Orthoptera, suborder Ensifera) Family of ensiferans, most of which are fully winged, although in some species wings are reduced or absent. Antennae are much longer than the body. There are about 600 species listed, including leaf-rolling grasshoppers and a number of desert species.

Gryllidae (bush cricket, field cricket, ground cricket, house cricket, short-winged cricket, sword-tailed cricket, tree cricket; class Insecta, order Orthoptera, suborder Ensifera) Large family of true crickets, most of which are winged, with the forewings box-like, and bent down at the sides of the body. The tarsi have no more than three segments, and the ovipositor is cylindrical. Many species show well-developed auditory communication. Some are of economic importance as pasture pests. There are about 2000 species.

Grylloblattodea (rock crawlers; class Insecta) Small order of exopterygote, wingless insects, which are slender, about 2–3 cm long; and have long, filiform antennae and cerci, and a sword-shaped ovipositor. They live in rock crevices, ice caves, and in rotting logs, and they are seldom seen. Their optimal temperature is just above 0 °C. They feed on moss, and are also predators and scavengers of other insects that have been immobilized by the cold. Rock crawlers occur in cold, wet, usually high-latitude areas of Japan, Siberia, and N. America. Only six species are known.

Gryllotalpa gryllotalpa *See* Gryllotalpidae.

Gryllotalpidae (mole crickets; class Insecta, order Orthoptera, suborder Ensifera) Fairly cosmopolitan family of relatively large, burrowing, mole crickets, which are greatly modified for digging. They have large, fossorial forelegs, a strongly convex prothorax, reduced forewings, a cylindrical abdomen, and no ovipositor. Some of the 50 or so species are wingless, and all stridulate. *Gryllotalpa gryllotalpa* is rare in Britain but common in continental Europe.

GTP (guanosine triphosphate) *See* guanosine phosphate.

Guaiacum (family Zygophyllaceae) Genus of trees some of which yield an extremely hard, dense, oily timber. Lignum vitae comes from *G. officinale* (and others). This species also yields a medicinal resin, guaiacum. There are six species, occurring in the W. Indies and tropical America.

guanaco (*Lama guanicoe*) *See* Camelidae.

guanido group The basic-group configuration $:C(NH_2)_2$ found in arginine.

guanine Purine base that occurs in both DNA and RNA.

guanosine The nucleoside formed when guanine is linked to ribose sugar.

guanosine phosphate Nucleotide of the purine base guanine. Guanosine phosphates are designated guanosine mono-, di-, and triphosphates (GMP, GDP, and GTP respectively). Cyclic-GMP is believed to be antagonistic in cells to cyclic-AMP, while GTP is involved as a high-energy compound in peptide bond synthesis.

guans *See* Cracidae; and *Penelope*.

guard cell Specialized type of plant epidermal cell, two of which surround each stoma. Changes in their turgidity cause stomatal opening and closing, the process being controlled by hormones.

Guarea (family Meliaceae) Genus of trees or treelets in which the leaves are pinnate, and the fruit is a capsule. W. African species yield the timber guarea. There are 35 species, occurring in the American and African tropics.

guava (*Psidium guajava*) *See Psidium*.

gudgeon *See* Eleotridae.

guenon (*Cercopithecus*) *See* Cercopithecidae.

guereza (*Colobus*) *See* Cercopithecidae.

guineafowl *See Guttera*; and Numididae.

guinea-pig (*Cavia*) *See* Caviidae.

Guinea zone The wettest and most wooded savannah zone in the classic three-fold model of savannah vegetation, which is based on examples taken from W. Africa. These are the Sahel zone, consisting of dry scrub with occasional grasses and patches of bare earth; typical grassy savannah; and the wetter, semi-wooded Guinea zone.

guitarfish *See* Rhinobatidae.

Gulf Stream The most important ocean current system in the northern hemisphere, which stretches from Florida to NW Europe. It incorporates several currents: the Florida current, the Gulf Stream itself, and an eastern extension, the N. Atlantic Drift. The Florida current is fast, deep, and narrow, but after passing Cape Hatteras the Gulf Stream becomes less effective at depth and develops a series of large meanders which form, detach, and reform in a complicated manner. After passing the Grand Banks (off Newfoundland), the flow forms the diffuse, shallow, slow-moving N. Atlantic Drift. The temperature (20 °C) and salinity (36 parts per thousand) tend to be seasonally constant, unlike neighbouring water masses.

gulf wobbegong (*Orectolobus ornatus*) *See* Orectolobidae.

gulls *See* Charadriiformes; Laridae; and *Larus*.

gully Deep incision that cuts into the regolith and bedrock due to surface run-off of water. *See also* erosion; and rill-wash.

Gulo gulo (carcajou, glutton, skunk bear, wolverine) *See* Mustelidae.

gulper 1 (*Eupharynx pelecanoides*) *See* Eurypharyngidae. 2 (whiptail) *See* Saccopharyngidae.

gum benjamin *See Styrax*.

gundi *See* Ctenodactylidae.

gunnel *See* Pholididae.

Gunnera (family Haloragaceae) Genus of plants, some of which are huge herbs cultivated for their giant, palmately-nerved leaves. The flowers are tiny, and borne in big panicles. The petioles have hollows, inhabited by blue-green algae. There are 50 species, occurring mainly in S. America, but also scattered in the southern temperate zone and the tropics generally.

guppy (*Poecilia reticulata*) *See* Poeciliidae.

gurjun *See Dipterocarpus*.

gurnard *See* Triglidae.

gust Sharp increase in wind strength close to the ground, caused by mechanical disturbance in an air flow. Gusts may also be generated by temperature lapse rates and by wind shear, e.g. in clear-air turbulence.

gutta percha Latex, mainly of Sapotaceae but also of Eucommiaceae and some Celastraceae. *Palaquium gutta*, of Sumatra, Java, Malaya, and Borneo, is the main source. The latex is obtained by tapping the bark or by crushing the leaves in hot water. It is a better thermal and electrical insulator than rubber, almost non-elastic, and plastic above 82 °C. It is now used only for temporary dental stoppings, but formerly it was used for submarine telephone cables. *See also* Sapotaceae.

guttation Extrusion of water and sometimes salts from the aerial parts of plants. This may happen in plants that are less than about 10 m high, where hydrostatic pressure is insufficient to prevent the flow of water into the xylem when the rate of transpiration is low.

Guttera (guineafowl; family Numididae) A genus of chicken-sized birds in which the plumage is white-spotted black, with crests of curly or straight feathers, and the rest of the head is bare with blue and red, or grey skin. They inhabit dense bush and forest, feed on insects and vegetable matter, and nest on the ground. There are three species, found in E., C., and W. Africa.

Guttiferae Family of trees and shrubs with leaves which are simple and opposite, and have oil glands. The flowers have cyclic or spiral petals and sepals, many stamens, and a superior, 3–5-locular ovary. Many species are useful for timber, and some have edible fruits. There are 40 genera, with 1000 species, occurring mainly in the tropics.

guyot Flat-topped submarine mountain or seamount, the summit of which lies 1000–2000 m below the ocean surface. The flat top may be a result of marine and/or subaerial erosion.

Gymnarchidae (class Osteichthyes, subclass Actinopterygii, order Mormyriformes) Family including only one species of freshwater fish, *Gymnarchus niloticus*. This has an eel-like body, small eyes, a very long dorsal fin, and pectoral fins; the pelvic and anal fins are absent. This fish grows to a length of at least 1.2 m, and can produce low-voltage electric currents using modified muscles in the tail region. It is found in tropical Africa.

Gymnoascaceae (order Eurotiales) Family of fungi in which the ascocarps do not have a definite wall or peridium. There are many genera. The family includes the perfect (sexual) stages of a number of important skin pathogens.

Gymnoblastina (Anthomedusae, Athecata, Tubularina; order Hydroida) Suborder of Cnidaria, in which the polyps and reproductive zooids are not protected. Medusae have gonads in the ectoderm of the manubrium (a projection around the mouth).

Gymnocanthus tricuspis (father lasher) *See* Cottidae.

Gymnocarpium (family Aspleniaceae) Genus of ferns: they have no indusium to the rounded, superficial sori; creeping rhizomes; and fronds that often appear three-lobed because the lowest pair of pinnae are each nearly as large as the rest of the frond. There are a few species in the northern temperate zone (e.g. oak fern), which are sometimes cultivated.

gymnocarpy Type of development of a fungal fruit body in which the spore-bearing tissue is naked and exposed during the whole of its development.

Gymnocranius griseus (grey large-eye bream) *See* Pentapodidae.

Gymnogyps californianus (California condor) *See* Cathartidae.

Gymnolaemata (phylum Bryozoa, subphylum Ectoprocta) Class of ectoproct bryozoans, in which the circular lophophore lacks a lip-like appendage covering the mouth. The body wall is non-muscular. The class extends from the Ordovician to the present.

Gymnophiona *See* caecilians.

Gymnorhina (Australian magpie; family Cracticidae) Monotypic genus, comprising *G. tibicen*. This is a black and white bird with a stout, pointed, black-tipped, white bill. It inhabits mainly open areas with trees, becoming tame in parks and gardens. It is a ground feeder, taking animals, fruit, and berries; and it nests in trees. There are three races, sometimes regarded as distinct species, found in Australia and New Guinea.

Gymnosomata (naked pteropods; phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods which typically have no shell or mantle cavity. They have a planktonic mode of life, aided by small parapodial fins. They are carnivorous.

Gymnospermae A subdivision of the seed plants (Spermatophyta), in which the ovules are carried naked on the cone scales, in contrast to the other subdivision of the Spermatophyta (the Angiospermae) in which they are enclosed by an ovary. Gymnospermae date from the Carboniferous, and subsequently they dominated the floras of the world until the Cretaceous, since when they have been progressively displaced by the Angiospermae (flowering plants).

Gymnostomatida (subclass Holotrichia) Order of ciliate protozoa in which the body cilia are uniformly arranged. The oral region lacks cilia, and the cytostome opens directly to the exterior. There are two suborders. They are found in marine and freshwater aquatic environments.

Gymnotidae (knife-eel; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish, which have an eel-like body with no fins, except for a very long anal fin and small pectorals; a small head and small eyes; and powerful jaws. *Gymnotus carapo* (banded knifefish), 30 cm, is sometimes kept in aquariums. Like the other species, it can produce weak electric currents. There are three species, occurring in C. and S. America.

Gymnotus carapo (banded knifefish) *See* Gymnotidae.

gymnure (Malayan moon rat, *Echinosorex gymnurus*) *See* Erinaceoidea.

gynaecium *See* gynoecium.

gynandromorph Animal that shows both male and female characteristics.

gynoecium (gynaecium) Collective term for the female reproductive organs of a flower, comprising one or more carpels. *Compare* androecium.

Gypohierax angolensis (palm-nut vulture) *See* Accipitridae.

Gyps (vultures; family Accipitridae) Genus of large vultures, with long, stout, hooked bills. The head and long neck are bare, with a ruff of feathers at the base of the neck. The wings are broad, the tail short, and the feet small with reduced talons which aid walking. Vultures inhabit open plains, mountains, and forests, feed on carrion, and nest in trees and on crags. There are seven species, found in Europe, Africa, and Asia.

gypsum Evaporite mineral, specific gravity 2.3, hardness 2, and with the chemical composition $CaSO_4.2H_2O$, that occurs in bedded deposits in association with halite and anhydrite. It is very insoluble and is therefore the first mineral to precipitate from evaporating sea-water; it is usually succeeded by anhydrite and halite. Occasionally it results from the reaction of sulphuric acid on limestone in volcanic areas. It can also result from the secondary hydration of anhydrite. It is distinguished by its low hardness. It can be clear white, but it can sometimes be shades of yellow, grey, red, and brown. It has a white streak, and a vitreous lustre. It is noted for its very good cleavage. It crystallizes in the monoclinic system. The crystals are usually tabular, often with curved faces, but gypsum can be massive or granular. Selenite is the colourless, transparent form; satin spar is the fibrous variety; alabaster is the fine-grained variety.

gypsy moth (*Lymantria dispar*) *See* Lymantriidae.

gyre Circular or spiral motion of water, the term usually being applied to a semiclosed current system. Major gyres correspond to major wind patterns; for example, there is an anticlockwise gyre in the subtropical zone south of the equator in each of the major oceans.

Gyrinidae (whirligig beetles; class Insecta, order Coleoptera) Family of fast-moving, gregarious beetles which swim in small circles on the surface of ponds. They have dark, shiny elytra. The antennae are short and stout. The eyes are divided for vision above and below the water surface. The middle and hind legs are paddle-like swimming structures, but the forelegs are modified for grasping prey. They feed on insects found on the water surface. Larvae are predatory and bottom-dwelling, with 10 pairs of feathery, external gills. There are 700 species.

Gyrinocheilidae (sucker loach; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) A small family of tropical freshwater fish, which have a slender body, large eyes, and a single dorsal fin placed slightly ahead of the pelvic fins. The mouth is placed almost in line with the flat belly. The thickly built 'lips' enable the fish to attach itself firmly to rocks, but normally they are used to scrape algae from the surface of the rock. *Gyrinocheilus aymonieri* (stonesucker), 25 cm, is kept as an aquarium fish. There are about three species, occurring in SE Asia.

Gyrinocheilus aymonieri (stonesucker) *See* Gyrinocheilidae.

gyroconic Applied to the conch of a cephalopod when it coils relatively loosely.

Gyrocotylidea (phylum Platyhelminthes, class Monogenea) An order of parasitic, platyhelminth worms all of which lack a gut. They are endoparasitic, living in certain fish.

Gyropidae (order Phthiraptera, suborder Amblycera) Family of chewing lice, which occur in S. America, where they are parasitic on caviomorph rodents. Unlike most other mammal-infesting lice, which hold the host's hair between the tarsal claw and the apex of the tibia, Gyropidae clasp the hair between the tarsus and the side of the tibia or between the side of the tibia and the side of the femur. The surfaces of the leg contacting the hair are ridged to provide greater purchase, a feature that distinguishes Gyropidae from other lice. There are eight genera, with 61 species.

gyrose Sinuous, curved; marked with curved lines or grooves.

Gyrostemnon (family Phytolaccaceae, subfamily Phytolaccoideae, section Gyrostemoneae) Genus of

trees, shrubs, or undershrubs, which have alternate, simple, entire, and often succulent leaves. The flowers are mostly unisexual, and the plants dioecious. They are solitary, axillary, or racemose. The perianth is a whorl of 4–5 segments which are usually flattened, and petals are usually absent. The ovary is superior with uniovular carpels. The fruit is a dry nut. There are six species, all endemic to Australia, and mainly restricted to the south-west.

Gyrostemonaceae Group of plants that was recognized formerly as a separate family, but that is now included in the family Phytolaccaceae.

gyttja (nekron mud) Rapidly accumulating, organic, muddy deposit, characteristic of eutrophic lakes. The precise nature of gyttja varies with the producer organisms involved, which include small algae or macrophytes.

H

haar Especially in coastal areas of E. Scotland and NE England, common term for a sea fog: these are frequent in early summer.

habenular commissure Band of nerve fibres which link the habenular ganglia of each cerebral hemisphere of the forebrain.

habitat Living place of an organism or community, characterized by its physical or biotic properties.

habituation Decrease in responsiveness that occurs when a stimulus is repeated frequently.

haboob From the Arabic *habb* meaning 'to blow', a local term for a dust storm in N. Sudan. Typically, the storm is experienced late in the day during summer.

hadal zone The part of the ocean that lies in very deep trenches below the general level of the deep-ocean floor (the abyssal zone).

haddock (*Melanogrammus aeglefinus*) *See* Gadidae.

Hadley cell One of the most fundamental divisions of the global wind circulation, comprising the net ascent of air over the lowest latitudes due to convection, the compensatory downward motion in the subtropical anticyclone belt, and the resulting trade winds which blow toward the meteorological equator (intertropical convergence). It is named after G. Hadley, who in 1735, seeking to account for the trade winds, proposed a single, large-scale convective cell representing a thermally-driven, low-latitude atmospheric circulation.

Hadromerida (class Demospongiae, subclass Tetractinomorpha) Order of sponges whose body has a radial structure. Spicules and organic fibres form the skeleton. The cortex is simple. Oviparous forms reproduce sexually. Some live in holes they have bored. They first appeared in the Cambrian.

Hadrosauridae Duck-billed ornithischian dinosaurs of possibly amphibious habits which averaged about 9 m in body length. Several mummies of hadrosaur dinosaurs have been found, from which it was possible to establish that they were unarmoured and that the digits of the forelimbs were connected by a web of skin. Hadrosaurs flourished in the Upper Cretaceous.

haem (heme) Metal–chelate complex in which iron is bonded to the four nitrogens of a porphyrin ring structure.

haematite (hematite, iron glance, kidney ore, red iron ore, specular iron, specularite) Iron mineral, specific gravity 4.9–5.3, hardness 5.0–6.0, chemical composition Fe_2O_3, whose name is derived from the Greek word for 'blood'. It is widely distributed as an accessory mineral in igneous rocks, in hydrothermal veins, as a rock-forming mineral in sedimentary rocks, as a primary mineral as concretions or a cementing agent, and also as a replacement for other minerals. Bedded ores of haematite form huge deposits in the Precambrian of N. America and elsewhere. It is distinguished by its red streak and its hardness. It is steel-grey to black, and often iridescent; compact varieties are dull to bright red, with a red to reddish-brown streak, and a metallic lustre. It crystallizes in the trigonal system. The crystals are tabular or rhombohedral with curved, striated faces. It also forms columnar, mammillated, and botryoidal masses. It is one of the main ores for iron.

Haematomyzidae *See* Rhyncophthirina.

Haematomyzus elephantis (elephant louse) *See* Rhyncophthirina.

Haematomyzus hopkinsi (warthog louse) *See* Rhyncophthirina.

Haematopinidae (order Phthiraptera, suborder Anoplura) Family of sucking lice which are parasitic on mammals in the Artiodactyla and Perissodactyla. Members of this family lack eyes but possess very prominent ocular points (non-sensory conical projections from the side of the head at the position occupied by the eyes in other lice). There is only one genus, *Haematopinus*, with 22 species.

Haematopodidae (oystercatchers; order Charadriiformes) Family of large, black, or black and white waders, which have long, stout, orange-red bills, and thick, orange legs with three webbed toes. They run and swim well, are very noisy, and inhabit coastal shores, where they feed on molluscs, crustaceans, worms, and insects. They nest on the ground. There is one genus, *Haematopus*, containing about eight species: it is found in Europe, Asia, N. and S. America, Australia, and New Zealand.

Haematoxylum (family Leguminosae, subfamily Caesalpinoideae) Genus of trees which have thorns in their leaf axils. The heartwood is coloured. *H. campechianum* (logwood) yields haemotoxylin, used for staining and dyeing. There are three species, occurring in C. and S. America, and in SW Africa.

haemocoel In some invertebrates, a body cavity filled with blood. *See also* coelom.

haemocyanin (hemocyanin) Blue, copper-containing respiratory pigment found free in the blood plasma of molluscs and crustaceans. It is a non-haem compound that is a polymer of smaller monomeric units.

Haemodoraceae Family of tropical and warm-temperate herbs with fibrous roots, tubers, rhizomes or stolons. Leaves are linear with sheathing bases. Bisexual flowers are borne in racemes, cymes, or panicles, and are often covered with

woolly hair. The perianth is persistent. The ovary is superior or inferior, and trilocular. The fruit is a capsule; there is a small embryo and a good-sized endosperm in the seeds. Several species of *Angiosanthos* are cultivated. There are 17 genera, with about 100 species, found in Australia, S. Africa, and tropical and N. America.

haemoglobin (hemoglobin) Conjugated protein that binds molecular oxygen in a loose, easily reversible manner and is used as a respiratory pigment in numerous groups of animals, particularly the vertebrates. Each haemoglobin molecule is a tetramer of four peptide chains, each bound to a haem group. In lower animals the haemoglobin occurs freely in the blood plasma, but in the vertebrates it is confined on the surface of specialized blood cells, the erythrocytes.

haemolysis (hemolysis) Rupture of red blood cells and the dissolution of their contents.

haemophilia Disease in humans (particularly males) in which blood clotting is defective. It is determined by a sex-linked recessive gene.

Haemophilus Genus of bacteria not assigned to a taxonomic family. The cells are small, ovoid to rod-shaped or occasionally filamentous, Gram-negative, and non-motile. There are many species. They are strictly parasitic in animals, including humans, and sometimes cause disease.

haemopoiesis (hemopoiesis) The formation and development of red blood cells (erythrocytes). In mammals and birds these cells arise from reticular cells in the bone marrow.

Haemosporina (order Eucoccidia) Suborder of protozoa in which gametocytes develop independently, i.e. syzygy does not occur. More than one host species is required for the completion of the life cycle. The sexual stages occur within an insect host, while asexual reproduction occurs in a vertebrate host. There are three families, and several genera, including the malarial parasite *Plasmodium*.

hag Parcel of wood that has been marked off for cutting. *See also* cant; and coupe.

hagfish *See* Myxinidae.

Haglidae *See* Prophalanopsidae.

hail Form of precipitation comprising ice in the shape of balls or irregular particles (hailstones), whose concentric structure indicates a growth by coalescence and freezing of supercooled water drops. Hail is usually associated with cumulonimbus cloud.

hair hygrometer Instrument that indicates relative humidity, based on the expansion and contraction of a treated human hair.

hair moss Common name for the moss *Polytrichum commune*. It is one of the largest British mosses, being 15–20 cm (exceptionally 40 cm) tall. Leaves may be 1 cm or more in length, with fine points, glossy sheathing bases, and toothed margins (visible with a hand lens). The capsule is sharply four-angled. The common name derives from the golden, hairy calytra, which is very conspicuous. Hair moss is common on damp heathland, moorland, and on mountains where the soil is acid; it often forms conspicuous mounds.

hair-streaks *See* Lycaenidae.

hairtail *See* Trichiuridae.

hairworms *See* Nematomorpha.

hake (*Merluccius merluccius*) *See* demersal fish; and Merluccidae.

Hakea (family Proteaceae) Genus of shrubs and trees with alternate, rigid leaves, which are often glabrous and aromatic, or silky. The flowers are held in crowded axillary clusters or racemes, and are bisexual, paired, and on stalks. The bud scales are papery, folded, and conspicuous, but fall early. The perianth segments are irregular and in the bud fused into a tube, but later the lobes are free and spreading. The stamens are found at the base of some of the perianth blades. The ovary is unilocular with two ovules, and the style protrudes from the perianth. The fruit is a woody capsule, and the seeds are slightly convex with a broad terminal wing. There are about 130 species, endemic to Australia.

Halcyon (kingfishers; family Alcedinidae) Genus of brightly-coloured, mainly blue, green, red, and white kingfishers, which inhabit dry areas of woodland and forest. They feed on insects, worms, frogs, and some fish, and nest in holes in banks and trees. There are about 40 species, found in Africa, Asia, Australia, and the Pacific islands. *H. chloris* (white-collared kingfisher) has nearly 50 subspecies.

Halcyon chloris (white-collared kingfisher) *See Halcyon*.

Haletta semifasciata (blue rock whiting) *See* Odacidae.

halfbeak *See* Exocoetidae.

half-life *See* radiometric dating.

half-sib mating Mating between individuals that have one parent in common, i.e. between half-brother and half-sister.

Halgania (family Ehretiaceae) Genus of trees and shrubs, which have entire or toothed, simple, alternate leaves without stipules. The regular, bisexual flowers are held in cymes. The fused calyx forms a long, deeply cut tube, and is often leaf-like and persistent. The petals form a five-lobed corolla-tube with the stamens attached. The anthers are united, forming a cone around the style. The ovary is superior with 2–4 fused carpels and the same number of locules, each with two ovules. The fruit is a drupe. There are 15 species, all endemic to Australia.

Haliaeetus (fish eagles; family Accipitridae) Genus of large eagles, which have long, broad wings, short tails, a large, strong bill, and short legs with strong talons. Most have white tails and heads, and brown bodies and wings. They are found near sea coasts, lakes, and rivers. They feed on fish, mammals, and birds, and nest in trees or on crags. There are eight

species, found in Europe, Asia, N. America, and Australia. *H. albicilla* (white-tailed eagle) has been reintroduced to Britain.

Haliaeetus albicilla (white-tailed eagle) *See Haliaeetus*.

Halichondrida (class Demospongiae, subclass Ceractinomorpha) Order of sponges that have many skeletal spicules, present in an unarranged, irregular fashion. A thin dermis occurs, and this is often strengthened by spicules. Organic fibres are also present.

Halictidae (sweat bees; order Hymenoptera, suborder Apocrita) Large, cosmopolitan family of mining bees. They are of great interest to behaviourists because the family encompasses all the grades of sociality. Like those of the Colletidae, the brood cells are lined with macrocyclic lactones secreted by the Dufour's gland. The family is characterized by the loss of the mentum, submentum, and flabellum of the tongue, and by the strongly curved basal vein of the forewing. The family includes the genera *Dufourea*, *Halictus*, *Lasioglossum*, *Nomia*, and *Nomioides*. The cuckoo-bee genus *Sphecodes* is a kleptoparasite of other halictids. *Nomia melanderi* (alkali bee) is cultured in special soil plots in the western USA as a pollinator of *Medicago sativa* (alfalfa or lucerne). Small species of *Lasioglossum* are attracted to human perspiration and hence the name 'sweat bees'.

Halictus *See* Halictidae.

Haliomma vetustum (family Actinommidae) One of the earliest recorded species of radiolarians, characterized by a siliceous shell, and a member of a family whose members have a spherical or ellipsoidal shape and no internal spicule. *H. vetustum* is known from the Ordovician of Europe.

Haliplidae (class Insecta, order Coleoptera) Family of small, yellow, convex water beetles, 2–5 mm long. The hind coxae are expanded into large plates, the legs fringed with swimming hairs. Usually the beetles are found crawling on water plants. The aquatic larvae are noted for the long, fleshy processes of their body segments. Adults and larvae feed mainly on algae. There are 200 species.

halite (rock salt) Mineral, specific gravity 2.2, hardness 2.5, chemical composition NaCl. It is widely distributed in stratified evaporite deposits, associated with other water-soluble minerals, e.g. sylvite, and with gypsum and anhydrite of various geological ages. Large masses frequently form plugs which rise through and arch overlying sedimentary rocks, thereby forming oil traps. Halite is distinguished by its water-solubility, perfect cubic cleavage, and salty taste. It can be colourless, white, or shades of yellow, red, and blue; and it has a white streak, and a vitreous lustre. It crystallizes in the cubic system. The crystals are usually cubes, often with curved faces, but it can be granular and compact. It is widely used as a road dressing in icy weather.

halloysite *See* clay minerals.

Hallucigenia A unique, rather novel animal from the mid-Cambrian Burgess Shale of Canada, which was characterized by a rather worm-like body supported on seven pairs of stilt-like limbs. It also possessed seven tentacles on the upper surface of the body. The function of these and the life-style of the animal are unknown. *Hallucigenia* cannot be referred to any known phylum.

hallux 1 The 'great toe'. On the pentadactyl hind limb, the digit on the tibial side, which is often shorter than the other digits. 2 The first digit of the foot of a bird, forming the hind toe in many species. In some (e.g. Coliidae) it is reversible, in others (e.g. Apodidae) it points forward, but in some species it is reduced or absent.

halmyrolysis Early diagenesis, modification, or decomposition of sediments on the sea-floor. For example, both the breakdown of ferromagnesian minerals, and the growth of glauconite aggregates in sea-floor sediments, are types of halmyrolytic process.

halo Rainbow-coloured, sometimes white, ring around the Sun or Moon, caused by refraction by ice crystals when thin cirrus cloud obscures the luminary. *Compare* corona.

Halobacteriaceae Family of bacteria which can grow only in the presence of high concentrations of salt (sodium chloride). Cells are spherical or rod-shaped, with cell walls atypical of the bacteria. They are chemo-organotrophic. There are two genera, found in most saline environments: the sea, salt lakes, salted foods, etc.

Halobacterium (family Halobacteriaceae) Genus of bacteria which require the presence of salt for survival and growth; in the absence of salt the cells disintegrate. Some strains can carry out a unique type of energy-yielding process, obtaining energy directly from sunlight in a non-photosynthetic process which involves a specialized region of the cell membrane called the 'purple membrane'.

halo blight Bacterial disease of dwarf and runner beans, usually caused by *Pseudomonas phaseolicola*. Symptoms include the appearance of brown spots on the leaves, each spot being surrounded by a yellow ring or halo, and infected plants may be stunted.

halocline A gradient of salinity.

halophilic Thriving in, or preferring to grow in, the presence of salt.

halophyte Plant adapted morphologically and/or physiologically to grow in saline environments, e.g. *Salicornia* species (glassworts). *See also* salt marsh.

Haloragaceae Family of aquatic or marsh herbs, with either whorled, much divided leaves (e.g. *Myriophyllum* and *Haloragis*), or enormous, radical, rhubarb-like leaves (e.g. *Gunnera*). The flowers are inconspicuous and solitary, in axils of spikes or dichasia, with no, or two or four tiny sepals and petals, and short stamens. The ovary is inferior and wind-pollinated. There are about 160 species, in seven genera. Distribution is cosmopolitan, but mainly in the southern hemisphere. *Gunnera* has disjunct distribution (S. America, S. Africa, SE Asia, and Australasia), possibly due to continental drift.

Haloragis (raspwort; family Haloragaceae) Genus of rough, perennial herbs, with opposite or alternate leaves which are entire, toothed, or lobed. The flowers are unisexual or bisexual, small, and held in terminal panicles or racemes. The 2–4 sepals are united into a tube with erect but short lobes, and are usually persistent, remaining over the ovary. The calyx tube is usually ribbed. The 2–4 petals are keeled and incurving, often hairy on the outer side, and often absent in female flowers. There are twice as many stamens as petals, and each has a short filament and a long anther. There are 2–4 carpels, with the same number of styles. The fruit is a small nut with single-seeded locules, which sometimes abort. There are about 75 species, found mostly in Australia, but with a few in Asia, New Zealand, and S. America.

Halosauridae (class Osteichthyes, subclass Actinopterygii, order Notacanthiformes) Small family of very elongate deep-sea fish, with short dorsal, pectoral, and pelvic fins, but with a long anal fin. They have a subterminal mouth and relatively large scales. There are about 14 species, found worldwide, often near the edges of continental shelves.

halosere Characteristic sequence of communities associated with the developmental stages in plant succession on salt-marshes. *See also* succession.

halo spot Disease of barley, caused by the fungus *Selenophoma donacis* (*Septoria oxyspora*). Lesions on upper leaves have pale centres with dark margins. The disease is important only in a few regions of Britain, including the wetter western regions of England, Wales, and Ireland.

haltere In Diptera (true flies), the modified hind-wing, shaped like a drum stick, and used as a balancing organ. Tiny, campaniform sensilla on the shaft provide feedback information into the central nervous system, and enable the fly to sense direction and movement in flight.

hamada (hammada) High desert plateau terminated by steep scarps and often incised by wadis. Two basic types occur: the stony hamada, jaggedly developed across crystalline rocks, and the pebbly hamada, cut across sedimentary material and mantled with bedrock fragments. Locally bedrock may be exposed.

hamadryad *See Ophiophagus hannah*.

hamadryas (baboon) *See Papio*.

Hamamelidaceae Family of trees and shrubs, which have simple or palmate, alternate leaves with stipules. The flowers are either bisexual or unisexual, and the plants either monoecious or dioecious. The flowers are usually held in a spike. The calyx is four or five united sepals and the same number of petals. There are up to 14 stamens. The position of the ovary is variable from one species to another; it always has two locules and two styles. The fruit is a woody exocarp or brittle endocarp. There are 23 genera, with more than 100 species; and representatives of the family are found throughout subtropical and temperate zones of the world. Each species has a more restricted distribution, however. Several genera give useful timbers and aromatic gums, e.g. *Liquidamber*. *Hamamelis* is the genus of witch hazel of which *H. virginiana* gives the soothing lotion used in medicine. Other species are ornamentals.

Hamamelis virginiana (witch hazel) *See* Hamamelidaceae.

hammada *See* hamada.

hammerhead *See* Scopidae.

hammerhead shark *See* Sphyrnidae.

hammocks *See* Everglades.

hamster *See* Cricetidae.

hamula In some Apterygota, a ventral abdominal appendage supporting the springing organ. *See also* Collembola.

hamulus (pl. hamuli) In Hymenoptera, a row of hooks along the costal margin of the hindwing which attach to a fold in the forewing.

hanging valley Tributary valley whose floor is well above that of the adjacent main valley and where there is therefore often a waterfall. It is typical of glaciated uplands, where it may result from glacial widening and/or deepening of the main valley.

Hanguana (family Flagellariaceae) Genus of one or a few species of giant herbs of the swamps and forests of the tropical Far East. They have petiolate leaves in a rosette or on a short stem, and their flowers are unisexual.

Hansen's disease *See* leprosy.

Haploactinidae *See* Aploactinidae.

Haplochitonidae *See* Aplochitonidae.

haplodiploidy Genetic system in which males develop from unfertilized eggs and so are haploid, whereas females develop from fertilized eggs and are diploid. It is found in honey bees, ants, wasps, spiders, and rotifers.

haploid number The number of chromosomes in a gamete, designated *n*, It is in contrast with the number of chromosomes in e.g. somatic cells, which is usually some multiple of this number, usually $2n$ (diploid), but sometimes $3n$ (triploid), $4n$ (tetraploid), or many-*n* (polyploid). A haploid cell thus has only one chromosome set, and a haploid organism contains only haploid cells.

Haplomi Name for an order of bony fish, no longer recognized, that included the pikes (Esocidae), the Umbridae, and the Galaxiidae.

Haplorhini (cohort Unguiculata, order Primates) Suborder comprising the anthropoids (superfamilies Ceboidea, Cercopithecoidea, and Hominoidea) and the tarsiers (otherwise classified as the infraorder Tarsiiformes), in all of which the upper lip is whole and the placenta haemochorial (with a very intimate embryonic–maternal connection). On these and other grounds—including the proportion of proteins that are shared among primate groups—the tarsiers show closer affinities to the anthropoids than they do to the lemurs. The Haplorhini are contrasted with the remaining primate groups, which are placed in the suborder Strepsirhini.

Haplosclerida (class Demospongiae, subclass Ceractinomorpha) Order of sponges that includes freshwater forms. If the skeleton is present it is either of siliceous spicules, or organic fibres, or both. A dermis is not common, and where it does occur it is simple. The order first appeared in the Cambrian.

Haplosporea (subphylum Sporozoa) Class of protozoa that form spores with a resistant outer covering. There is one order. They are found as parasites in various invertebrates.

hapten Small molecule that by itself is non-allergenic, but that when combined with a larger carrier molecule forms a complex that reacts selectively with an antibody.

hapteron In phycology, a term sometimes used as a synonym of holdfast; it may also be used to refer only to root-like types of holdfast.

haptonema *See* Prymnesiophyceae.

Haptophyceae *See* Prymnesiophyceae.

haptotropism *See* thigmotropism.

hardening *See* acclimatization.

hardness scale (Mohs's scale) Scale, devised by the German mineralogist Friedrich Mohs (1773–1839), of the hardnesses of minerals, ranging from 1 (talc) to 10 (diamond). The scale is linear up to a hardness of 9 (corundum), but then rises dramatically to 10.

hardpan Hardened soil horizon, usually found in the middle or lower parts of the profile, that may be indurated or cemented by a variety of possible cementing materials. *See also* caliche; duricrust; and pan.

Hardy–Weinberg law Law that states that in an infinitely large, interbreeding population in which mating is random and in which there is no selection, migration, or mutation, gene and genotype frequencies will remain constant from generation to generation. In practice these conditions are rarely strictly present, but unless any departure is a marked one, there is no statistically significant movement away from equilibrium. Consider a single pair of alleles, *A* and *a*, present in a diploid population with frequencies of p and q respectively. Three genotypes are possible, *AA*, *Aa*, and *aa*, and these will be present with frequencies of p^2, $2pq$, and q^2 respectively.

hare-lipped bat (*Noctilio*) *See* Noctilionidae.

hares 1 *See* Leporidae. 2 (Cape jumping hare, *Pedetes*) *See* Pedetidae. 3 (mouse hare, *Ochotona*) *See* Ochotonidae. 4 (Patagonian hare, *Dolichotis*) *See* Caviidae.

harlequin (*Rasbora heteromorpha*) *See* Cyprinidae.

harlequin chromosome *See* sister chromatid exchange.

harmattan wind (the Doctor) Dry, dusty, northeasterly or easterly wind which occurs in W. Africa north of the equator. Its effect extends from just north of the equator in January, almost to the northern tropic in July. In W. Africa it is known as 'the Doctor' because of its invigorating dryness compared with humid tropical air. The harmattan wind stream occasionally extends south of the equator during the northern winter as an upper air wind over the south-westerly monsoon.

Harpactes (trogons; family Trogonidae) Genus of red, brown, black, and white trogons. They inhabit forests; feed on insects, reptiles, and amphibians; and nest in tree cavities. There are 11 species, found in India, China, SE Asia, and Indonesia. This genus is the only oriental representative of the family.

Harpadontidae (Bombay duck; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Family of marine and brackish-water fish, which have a torpedo-shaped body, a compressed head with small eyes and a large mouth, a single dorsal and an adipose fin, and a tri-lobed tail-fin. There are three species, of commercial value, in the Indo-Pacific region, for example *Harpadon nehereus* (41 cm).

harriers *See Circus*.

harvester ant *See Messor*.

harvester termites (Hodotermitinae) *See* Hodotermitidae.

harvestmen *See* Arachnida.

harvest method Productivity measuring technique, most commonly used for estimates of primary productivity, especially in situations in which predation is low, e.g. among annual crops, on certain heathlands, in colonizing grasslands, and sometimes in pond ecosystems. Sample areas are harvested at intervals throughout the growing season, and the material is dried to estimate dry weight or calorific value. The method may also be used for woodlands, although usually only one final felling and dry-weight estimation is feasible. In such situations it is generally more reliable and ecologically more desirable to use indirect, non-destructive estimates, e.g. by monitoring carbon-dioxide profiles. *Compare* aerodynamic method.

hashish (*Cannabis sativa*) *See Cannabis*.

hatchetfish *See* Gasteropelecidae; and Sternoptychidae.

hatching (of fish eggs) Process during which the developing fish wriggles free from the enveloping egg membrane; after this it is called 'larva' or 'fry'. Experiments on fertilized fish eggs have shown that water temperature is an important factor in the determination of the hatching period, i.e. the period between fertilization and hatching. The hatching period for eggs from *Salmo gairdneri* (rainbow trout) is about 14 days at 6 °C, but six days when the temperature is increased to 13 °C.

haulm Stem, for example those of bamboos and grasses.

haustorium In certain parasitic fungi, an outgrowth from a hypha that penetrates a host cell in order to absorb nutrients from it.

Hawaii Group of volcanic, oceanic islands in the Pacific Ocean, which are remote from any continent and which contain many endemic groups of

organisms which underwent adaptive radiation on the islands, e.g. the Drepanididae (honey creepers), and drosophilid flies. Like the Galápagos Islands, the Hawaiian archipelago has featured significantly in the development of evolutionary theory.

Hawaiian arrowroot *See* Taccaceae.

Hawaiian floral realm Part of Good's (1974) Polynesian subkingdom, which falls within his Palaeotropical kingdom, this is the most isolated floral region, which accounts for its great distinctiveness. About 20% of the genera and over 90% of the species are endemic. No valuable economic or horticultural plants belong to this region.

Hawaiian honeycreepers *See* Drepanididae; and *Loxioides*.

Hawaiian goose (*Branta sandvicensis*) *See Branta*.

hawaiite *See* andesite.

hawfinches *See Coccothraustes*.

hawk eagles *See Spizaetus*.

hawkfish *See* Cirrhitidae.

hawk moths *See* Sphingidae.

hawks *See* Accipitridae; *Buteo; Circus; Elanus*; and Falconiformes.

hawksbill turtle *See Eretmochelys imbricata*.

hay 1 Enclosure or hedge. 2 Part of a forest that has been fenced off for hunting. 3 Grass that has been conserved by drying and that is to be used later as feed or bedding for livestock.

hay-bote 1 Fencing material. 2 The right to collect undergrowth for feeding livestock. The term is derived from the original meaning of the words 'hay' ('hedge'), and 'bote', meaning 'bounty' or 'gift'.

haze Atmospheric condition in which visibility is reduced because of the dispersion of light by very small, dry particles, e.g. fine dust.

hazel *See Corylus*.

head Sheet of poorly-sorted, angular rock debris, mantling a hillslope and deposited by gelifluction. It is commonly found as a fossil deposit in the extra-glacial areas of N. America and Europe. 'Coombe rock' is similar, but is found on chalk.

head louse (*Pediculus capitis*) *See* Pediculidae.

head stander *See* Anostomidae; and Chilodontidae.

heap cloud General term applied to a cloud form that exhibits marked vertical development, e.g. cumulus cloud.

heart Muscular pump with valves, which causes blood to circulate. In Crocodilia, Aves, and Mammalia it operates a double circulation, the system supplying the lungs (pulmonary circulation) being separate from that supplying the rest of the body.

heart-urchins *See* Echinoidea; and Spatangoida.

heartwood The dead, woody centre of the trunk of a tree. The cells become impregnated with various organic compounds which cause a change in colour, so that this tissue is distinguished easily from the remainder of the wood.

heath butterflies *See* Satyrinae.

heath forest *See* keranga.

heathland Most typically a community dominated by ericoid dwarf shrubs. Sometimes, especially in Britain, 'heathland' is used more loosely to denote any community developing on acidic, podzolized soils, e.g. grass heaths and lichen heaths. *Compare* moor.

heaths *See Erica*.

heath potter wasp *See Eumenes coarctata*.

heavy-metal tolerance Biochemical and physiological adaptation to heavy metals shown by plant species or genotypes: such plants may therefore be found growing successfully on soils contaminated by metals, where other species or genotypes would fail. Many common grasses, e.g. *Agrostis tenuis* and *Festuca ovina*, have developed heavy-metal-tolerant strains naturally on soils derived from geological strata rich in heavy metals. Seeds from these genotypes are used commercially in revegetating metal-contaminated spoil.

Hebe (family Scrophulariaceae) Genus of shrubs very closely related to *Veronica*, but, unlike that genus, truly shrubby, and with the capsule dorsally (not laterally) compressed. They are much cultivated for the flowers and foliage. There are about 100 species in the extreme south of S. America, New Zealand, and Australia; the disjunct distribution is perhaps due to a former southern continent separating into component plates.

Hedera (ivy; family Araliaceae) Genus of woody root climbers, whose leaves are often dimorphic. There are 15 species, found in the Canary Islands, Europe, and eastward to Japan and Queensland.

hedgehog *See* Erinaceoidea.

hedge rat *See* Octodontidae.

hekistotherm Cold-tolerant plant of polar regions, according to A. P. A. de Candolle's (1874) classic temperature-based scheme of world vegetation zones.

HeLa cells *See* established cell line.

Helaletidae Eocene and Oligocene family of ceratomorph perissodactyls, related to the ancestral tapirs but showing distinct affinities also with the early rhinoceroses.

Helianthemum *See* Cistaceae.

Helianthus annus (sunflower) *See* Compositae.

Helianthus tuberosus (Jerusalem artichoke) *See* Compositae.

Helichrysum (everlasting daisies; family Compositae) Genus of herbs and shrubs which have entire, usually alternate leaves. The flower heads may be large (up to 5 cm in diameter), and solitary, or in panicles or clusters. The papery, dry, shiny involucre bracts extend beyond the flowers and have the appearance of petals; they are yellow, white, brown, or pink. The shrubby species often

have smaller flowers held in a terminal corymb. The disc-florets are mostly bisexual, tubular, and yellow. The anthers have short tails, and the style has cylindrical lobes. The fruit is a nut or achene with a single seed. Many species are cultivated, as the flowers can be dried and keep their colour for a long period. There are about 500 species, found in SE Europe, Africa, and Australia. The genus is centred in S. Africa, where more than 200 species are present.

Helicia (family Proteaceae) Genus of 90 species of trees and shrubs, which are too small to yield useful timber. They occur from S. China and Indo-Malaysia to Melanesia. They have simple leaves.

Heliciopsis (family Proteaceae) Genus of trees in which the leaves are dimorphic, and either simple or deeply lobed. There are 100 species, occurring in Burma, S. China, and W. Malesia.

Heliconia (family Scitamineae) Genus of giant, soboliferous herbs with banana-like leaves, and flowers borne in racemes, subtended by showy bracts. The fruit is a capsule. There are 80 species, occurring in tropical America and the SW Pacific.

Helicoplacus curtisi Primitive echinoderm recorded from the Lower Cambrian of N. America.

helictite *See* dripstone.

Heliocharitidae (Dicteriastidae, damselflies; order Odonata, suborder Zygoptera) Family of damselflies in which there are many secondary antenodals in the wing venation, and the second and third branch of the radius arches towards the first soon after its origin. The family is neotropical and 12 extant species have been described. *See also* venation.

heliophyte Plant characteristic of, and showing adaptation to, bright, sunlit habitats, as opposed to shade-tolerant or shade-preferring species.

Heliornithidae (sungrebes, finfoots; order Gruiformes) Family of small to large, olive-brown or brown birds, which have a long, thin head, and broadly-lobed toes. They inhabit the edges of rivers and lakes; feed on insects, molluscs, and small aquatic invertebrates; and nest low in bushes. They swim, dive, and run well, but rarely fly. There are three monotypic genera, found in C. and S. America, Africa, and S. Asia.

heliotropic (phototropic) Applied to a plant or part thereof that shows a directional growth movement in response to light.

Heliozoia (class Actinopodea) Subclass of protozoa, which have a spherical cell body from which radiate many slender pseudopodia. In some species there is a porous test, the pseudopodia extending through the pores. There are three orders, found in freshwater lakes, ponds, rivers, etc.

Helipterum (everlasting daisies; family Compositae) Genus of mostly annual herbs which have alternate leaves. The flower heads are small or large, and solitary or in corymbs. The petal-like involucre bracts are soft and papery, and are white, yellow, brown, or pink; sometimes they are sensitive to moisture and close in damp weather. The disc-florets may be black. The pappus of the achene is branched and feathery. Several species are cultivated commercially for cut flowers. There are about 90 species, found in S. Africa and Australia, 60 of which are found in inland Australia.

hellgrammites *See* Corydalidae.

helmeted guineafowl (*Numida meleagris*) *See* Numididae.

helmetshrikes *See* Laniidae.

Helminthostachys (family Ophioglossaceae) Genus of ferns of one species, with a creeping rhizome, the sterile leaf-blade ternately compound, and a dense, fertile spike. It is confined to the Indo-Malaysian region, and Australasia, and is probably of very ancient origin.

helm wind Local name for a type of lee wave frequent in winter and spring on the western (lee) slope of the Crossfell range in Cumbria, England. Associated with this cold, gusty, north-easterly wind, the 'helm' is a thick bank of cloud along the mountain range, with an outlier of narrow, almost motionless cloud away from the range.

Heloderma suspectum (gila monster; order Squamata, suborder Sauria (Lacertilia), family Helodermatidae) Sluggish, nocturnal, venomous lizard, up to 60 cm long, which is mainly pink and yellow with black shading. It burrows in sand and preys mainly on small rodents. Its bite is seldom fatal to humans. It occurs in the deserts of SW USA and N. Mexico.

Helodermatidae (beaded lizards, venomous lizards; order Squamata, suborder Sauria (Lacertilia) Family that comprises the only poisonous lizards. The venom glands are at the rear of the lower jaw (unlike those of snakes). The body is cylindrical, with powerful limbs, and a thick, rounded tail. The upper surface is covered with large, bony scales. There are two species occurring from Nevada to Mexico. *See Heloderma suspectum*.

helophyte Plant, typical of marshy or lake-edge environments, in which the perennating organ lies in soil or mud below the water level, but the aerial shoots protrude above the water (e.g. *Phragmites communis*, the common reed). *Compare* hydrophyte.

Helostoma temminckii (kissing gourami) *See* Helostomatidae.

Helostomatidae (kissing gourami; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family including only one species of freshwater fish, *Helostoma temminckii*, the kissing gourami, a fish very popular with aquarium hobbyists because members of this species often contact one another with their thick lips. They are relatively short but deep-bodied fish, with long dorsal and anal fins, and may reach a length of at least 25 cm. They occur in SE Asia.

Helotiales (class Discomycetes) Order of fungi, in which the asci are more or less club-shaped; the ascospores are varied in shape. There are several families. They are saprotrophic or parasitic, and found in a variety of habitats.

helotism Relationship between two organisms in which one virtually 'enslaves' the other for its own benefit. The term is sometimes applied to lichens, where the alga is apparently 'enslaved' by the fungal partner.

Helvella (order Pezizales) Genus of fungi, in which the fruit body consists of a roughly saddle-shaped fertile head borne on a long, ribbed and furrowed stalk. *H. crispa* is whitish or cream-coloured, 4–10 cm tall, and found in autumn on the ground in broad-leaved woods.

hematite *See* haematite.

heme *See* haem.

hemera Period of geological time determined by the maximum development of a fossil plant or animal.

Hemiascomycetes (subdivision Ascomycotina) Class of fungi in which the asci are formed singly and not in ascocarps. The vegetative form of the organism may be mycelial or yeast-like (unicellular). There are three orders. They are saprotrophic, or parasitic in plants.

hemicellulose Heterogeneous group of compounds that in plant-cell walls form part of the matrix within which cellulose fibres are embedded. The two principal structural types are polymers of D-xylose and of glucose and mannose, known respectively as xylans and glucomannans.

Hemichordata (acorn worms) Phylum first encountered in the Middle Cambrian Burgess Shale, British Columbia, Canada. The acorn worms are related to the chordates, for although they lack a notochord, the gill slits are very similar to those of primitive vertebrates.

Hemicidaroida (superorder Echinacea) Order of regular echinoids, similar to the Cidaroida, but differing from them in having gill slits around the peristome. They have perforate and crenulate primary tubercles. They first appeared in the Upper Triassic.

hemicryptophyte One of Raunkiaer's life-form categories, being a plant whose perennating buds are at ground level, the aerial shoots dying down at the onset of unfavourable conditions. Three subcategories are recognized: (a) protohemicryptophytes, in which the lowest leaves on the stem are smaller than others, or scale-like, giving added protection to the bud (e.g. *Rubus idaeus*); (b) partial-rosette plants, in which the best-developed leaves form a basal rosette, but some leaves are also present on aerial stems (e.g. *Ajuga reptans*, bugle); and (c) rosette plants, in which the leaves are confined to a rosette at the base of the aerial shoots (e.g. *Bellis perennis*, daisy). *Compare* chamaeophyte; cryptophyte; phanerophyte; and therophyte.

hemielytron (pl. hemielytra) In Heteroptera (plant bugs and water bugs), a type of forewing which is of a leathery texture, except at the tip, which is membranaceous.

Hemigrammus erythrozonus (glowlight tetra) *See* Characidae.

Hemimeridae (earwigs; class Insecta, order Dermaptera) Family of earwigs which are well adapted as ectoparasites. They are flattened and streamlined, with specially modified tarsal segments with which they grip the fur of their hosts. They are wingless and blind, with rod-like forceps. There are about 10 species, all of which live in the fur of a particular species of *Cricetomys* (giant rat), in southern Africa.

hemimorphite *See* diopside.

Hemiodontidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish, which have a slender body, rather flat belly and low-slung mouth, and single dorsal and adipose fins; the tail-fin is strongly forked. Superficially these fish resemble some characid species, but they are distinguished by the absence of teeth in the lower jaw. Some species, e.g. *Hemiodus gracilis* (16 cm) are sometimes kept in aquariums. They occur in tropical S. America.

hemipenis In male Squamata, one half of the paired, erectile, copulatory organ, protruded through the cloaca. Only one hemipenis is inserted into the body of the female, which one being a matter of chance, and sperm is carried from the testes by ducts that open into the cloaca, whence it flows along a groove on the surface of the hemipenis.

Hemiphlebiidae (damselflies; order Odonata, suborder Zygoptera) Monospecific family whose only representative species is a tiny, metallic-coloured damselfly. It is characterized by the postnodal veins in the wing, which are not in line with the cross veins behind them. It occurs in Australia. *See also* venation.

Hemiprocnidae (tree swifts; order Apodiformes) Family of brown or grey swifts, many of which have a blue or green gloss to some feathers. The head is often crested, with white stripes above and below the eye. They have a non-reversible hallux, and are less aerial than other swifts, perching in trees. They inhabit forest edges and clearings, feed on insects, and build their nests on the sides of branches. There is one genus with four species, found in India, SE Asia, Indonesia, and New Guinea.

Hemiptera (true bugs; phylum Arthropoda, class Insecta) Order of insects in whose life cycle there is no true pupal stage, and which never have an eleventh abdominal segment or cerci. The mouthparts are modified into a rostrum or, in non-feeding stages of some species, are completely lacking. There are typically two pairs of wings, of which the anterior pair are usually wholly or partly toughened to protect the membranaceous posterior pair over which they are folded at rest. There are two suborders, Homoptera and Heteroptera.

hemlock firs *See Tsuga*.

hemocyanin *See* haemocyanin.

hemoglobin *See* haemoglobin.

hemolysis *See* haemolysis.

hemopoiesis *See* haemopoiesis.

hemp (*Cannabis sativa*) *See Cannabis*; and Cannabinaceae.

heparin Complex polysaccharide containing sulphur. It is found in many tissues, where it exhibits anticoagulant properties by preventing the conversion of prothrombin to thrombin.

Hepaticae (liverworts; division Bryophyta) Class of plants, characterized by a combination of features. The capsule is usually ovoid or spherical and does not have a lid; when ripe, it usually splits into four 'valves' to release the spores. A tubular perianth often surrounds the developing capsule. The seta is colourless and semi-transparent; it lengthens after the capsule has reached its full size, and is structurally much weaker than a moss seta. Liverworts may be 'thallose' (i.e. flattened and showing no differentiation into stem and leaves) or 'leafy', with leaves normally arranged in two or three distinct ranks. The leaves never have a thickened nerve or midrib, and are often lobed or segmented. Typically the thallus is attached to a substrate by means of unicellular rhizoids. Liverworts are found in a variety of habitats, particularly in moist conditions.

hepatitis Inflammation of the liver, caused by infection with a virus, the nature of the disease depending on the virus concerned. With hepatitis A virus, the disease develops fairly rapidly and is not usually severe; with hepatitis B virus, the disease takes longer to develop and can become chronic. It may also be caused by non-A and non-B viruses.

Hephaestus fuliginosus (sooty grunter) *See* Theraponidae.

Hepialidae (swift moths, ghost moths; order Lepidoptera) Family of medium to very large moths, in which the wings are generally rounded apically; venation is similar in forewing and hindwing; and the wings are coupled in flight by an overlapping lobe of the forewing (jugum). Females scatter their eggs over vegetation; the larvae feed on roots or in wood. Hepialidae have a global distribution.

Hepsetidae (pike characin; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish with only one species, the pike characin (*Hepsetus odoe*). This has an elongate pike-like body, a large mouth, a forked tail-fin, and the dorsal and anal fins placed well back. It is a voracious fish, which may grow to 1.8 kg and is prized by fishermen. It occurs in tropical Africa.

Hepsetus odoe (pike characin) *See* Hepsetidae.

heptamerous Having seven parts.

Heptapsogasteridae (order Phthiraptera, suborder Ischnocera) Family of chewing lice, which occur in S. America where they parasitize birds of the order Tinamiformes. Heptapsogasteridae differ from other Ischnocera in the fusion of the first three abdominal segments, the first pair of abdominal spiracles appearing on the first visible segment. There are 15 genera, with about 130 species. This is a very high number of species for a host group of less than 50 species.

herbage 1 Growing plants on which domestic animals feed. 2 Ground vegetation (herbs), especially grass, when these are considered as an agricultural crop. 3 Payment made to the owner of an area of land in return for permission to graze livestock on that land.

herbicide Chemical substance which suppresses, and is usually designed to eliminate, plant growth. It may be a blanket 'weed' killer (e.g. paraquat); or selective, for example eliminating dicotyledonous plants from among monocotyledonous stands (e.g. phenoxyacetic acids) or vice versa (e.g. dalapan). A notable consequence of this kind of chemical control in cereal crops is the decline in typical weeds, e.g. poppy, and the increase of weed grasses, e.g. *Avena fatua* (wild oat), and *Alopecurus myosuroides* (black grass).

herbivore Heterotrophic animal that obtains energy by feeding on primary producers, most usually green plants. *See also* food-chain; *compare* carnivore; and detritivore.

herbivorous fish Fish that feed exclusively or predominantly on aquatic plants or algae, e.g. *Girella tricuspidata* (luderick) and *Ctenopharyngodon idella* (grass carp).

Hercules beetle *See* Scarabaeidae.

herding Formation by mammals of groups of individuals with a social organization. Usually the term is restricted to the behaviour of large herbivores.

hereditary disease Disease that is caused by a mutant gene and that may be transmitted from one generation to the next.

Heriades *See* Halictidae.

Hericium (family Hydnaceae) Genus of fungi in which the hymenium is borne on tooth-like projections. The fruit body is typically extensively branched, and white or cream-coloured, with teeth that typically hang downwards. The spores are colourless, spherical or nearly so, and turn a dark violet colour when treated with iodine. Species are parasitic on trees, or grow on dead wood, stumps, etc.

heritability Measure of the degree to which a phenotype is genetically influenced and can be modified by selection. It is represented by the symbol h^2: this equals V_a/V_p where V_a is the variance due to genes with additive effects (known as the additive genetic variance) and V_p is the phenotypic variance. The variance V may also be written as s^2. Parent–offspring correlations, as used in studies of the heritability of human IQ, are estimates of familiality and not of heritability: they cannot account for environmental correlations between relatives. This definition of heritability is a narrow one: heritability in the broad sense (represented by H^2) is the fraction of total phenotypic variance that remains after exclusion of the variance due to environmental effects.

Heritiera *See* mengkulang.

Hermann's tortoise *See Testudo hermanni*.

hermaphrodite With both sexes; bisexual. *See* androecium; and bisexual.

hermaphroditic fish Fish that, when mature, possess both male (testes) and female (ovary) sex glands at the same time. In such species cross-fertilization can occur during spawning. In other species, e.g. Sparidae (sea bream), the testes develop first, these males turning into females as the fish grow larger and older. Most Serranidae (sea perches) are females first or have both sets of glands equally developed.

hermatypic Applied to corals that contain zooxanthellae and are reef-forming. Modern scleractinian hermatypic corals are characterized by the presence of vast numbers of symbiotic zooxanthellae (unicellular dinoflagellates) in their endodermal tissue. They live in waters of normal marine salinity, at depths of up to 90 m, in temperatures above 18 °C, and grow vigorously in strong sunlight.

hermit crabs *See* Paguridae; and *Pagurus bernhardei*.

hermits *See Phaethornis*.

Hernandia (family Hernandiaceae) Genus of plants in which the leaves are simple; and the flowers unisexual, and borne in long panicles. The fruit is a nut enclosed in an inflated, papery envelope. There are 20 species, with a pantropical distribution.

Hernandiaceae Small family of shrubs, trees, and climbers, in which the leaves are palmately-nerved, there are 6–10 free perianth lobes and 3–5 stamens, and the ovary is inferior and unilocular. The fruit is indehiscent. They are related to Monimiaceae. There are four genera, containing 35 species, with a pantropical distribution.

herons 1 *See Ardea*; and Ardeidae. 2 (boat-billed heron) *See* Cochleariidae. 3 *See Egretta*. 4 (night herons) *See Nycticorax*.

herpangina Acute, infectious human disease involving fever, a sore throat, and the development of vesicles (papules) in the pharyngeal region. It is caused by a coxsackievirus.

herpes simplex virus Virus within the herpesviruses which includes two types: one type can cause various localized conditions such as cold sores, inflammation of the gums and mouth, etc., while the second type appears to be associated with the formation of cervical tumours.

herpesviruses (Herpesviridae) Group (family) of enveloped, DNA-containing viruses in which the virions are quite complex in structure. Herpesviruses can infect a wide range of animals, and often cause latent infections, no symptoms being apparent for many years. The group includes the causal agents of many localized and generalized diseases, e.g. cold sores, chickenpox, and some types of tumour.

herpes-zoster *See* shingles.

herring smelts (argentines) *See* Argentinidae.

Hertfordshire puddingstone *See* sarsen.

Hesperapsi *See* Melittidae.

hesperidium Berry of a citrus fruit (Rutaceae), i.e. a fruit whose fleshy parts are divided into segments, the whole being surrounded by a separable skin.

Hesperiidae (skippers; order Lepidoptera) Large family of butterflies in which the wings are short compared with the large head and body. In contrast with other butterflies, the antennae are widely separated basally. The antennae are often clubbed, and extend into a short point terminally. The larvae are generally grass-feeders. The family has a wide distribution, but is absent from New Zealand.

hessian fly (*Mayetiola destructor*) *See* Cecidomyidae.

Heteralocha acutirostris (huia) *See* Callaeidae.

heteroalleles *See* homoallelic.

Heterobasidion (family Polyporaceae) Genus of fungi in which clamp connections are absent and fruit bodies are resupinate to dimidiate. *H. annosum* (formerly *Fomes annosus*) is an important pathogen of trees, particularly conifers, in which it causes decay of heartwood and roots. Woody fruit bodies occur at the base of the infected tree and are orange-brown with a white margin. They are found throughout temperate regions.

heterocaryon *See* heterokaryon.

heterocercal tail In fish, a tail in which the tip of the vertebral column turns upward, extending into the dorsal lobe of the tail-fin; the dorsal lobe is often larger than the ventral lobe. The heterocercal tail is present in many fossil fish, in the sharks (Chondrichthyes), and in the more primitive bony fish, e.g. the families Acipenseridae and Polyodontidae.

heterochromatin Chromosome material that accepts stains in the interphase nucleus (unlike euchromatin). Such regions, particularly those containing the centromeric and nucleolus organizers, may adhere to form a chromocentre. Some chromosomes are composed primarily of heterochromatin: these are termed heterochromosomes. In many species, the Y-chromosome is a heterochromosome.

heterochromosome *See* heterochromatin.

heterochrony Dissociation, during development, of factors of shape, size, and maturity, so that organisms mature in these respects at earlier or later growth stages. This leads to (a) paedomorphosis, or (b) recapitulation.

Heterocorallia (subclass Zoantharia) Small order of corals, known only from Carboniferous rocks in Europe and Asia, and represented by two genera. It is included in the Zoantharia because its members possess septa, and because of the microstructure of the calcareous skeleton. The septa are arranged differently from those in the other orders. The four original septa are conjoined axially, and new septa are formed attached to these at their axial ends.

heterocotylized arm In Cephalopoda, a specialized tentacle used for the transfer of sperm.

heterocyst Specialized cell found in certain types of cyanobacteria; heterocysts are sites of nitrogen fixation.

Heterodendrum (Australian rosewood; family Sapindaceae) Genus of small trees which have small, lanceolate or linear leaves. The flowers are held in panicles and have no petals. The fruit is five-lobed, each lobe being single-seeded. There are five species, all endemic to Australia.

heterodimer Protein comprising paired polypeptides that differ in their amino-acid sequences.

heterodont Possessing teeth that are differentiated into several forms, e.g. incisors, canines, premolars, molars.

Heterodonta (phylum Mollusca, class Pelecypoda) Subclass of pelecypods, which have heterodont dentition consisting of a hinge plate with distinct cardinal teeth below the umbo, and lateral teeth posterior to the cardinals. Some forms may be desmodont. The ligament is opisthodetic. Shell shape varies according to the mode of life of the organism, most having a crossed-lamellar, aragonitic shell structure. Heterodonta are mainly infaunal siphon-feeders, the siphons being well developed. They have eulamellibranchiate gills and an isomyarian musculature, and the pallial line is entire or with a sinus. They first appeared in the Middle Ordovician.

Heterodontidae (Port Jackson shark, bullhead shark; class Chondrichthyes, subclass Elasmobranchii, order Heterodontiformes) Small family of marine sharks, characterized by two dorsal fins each preceded by a stout spine; the eyes are protected by a dorsal ridge marking the otherwise blunt head profile. These sharks are bottom-dwelling and fairly slow-moving animals, feeding on molluscs, crabs, etc. *Heterodontus portusjacksoni* (Port Jackson shark) grows to a length of about 1.6 m and is found in Australian temperate to tropical waters. There are about six species, occurring in the Indo-Pacific region.

Heterodontiformes Order of marine sharks including only the family Heterodontidae.

Heterodontosauridae Ornithopod ornithischian dinosaurs, known only from the Upper Triassic of S. Africa. These 'different-toothed lizards' had tusk-like canines.

Heterodontus portusjacksoni (Port Jackson shark) *See* Heterodontidae.

heteroecious (heteroxenous) Applied to a parasitic organism in which different stages of the life cycle occur in different species of host organism.

heterogametic sex The sex that has sex chromosomes that differ in morphology (e.g. XY), and that therefore produces two different kinds of gametes with respect to the sex chromosomes. The term may also refer to the possession of an unpaired sex chromosome (a single X-chromosome). In mammals and most other animals, the male is the heterogametic sex, usually with equal numbers of different gametes X and Y, although some men, for example, have XXY or even XXXY. In birds, reptiles, some fish and amphibians, and Lepidoptera, the female is the heterogametic sex.

heterogamy The alternation of reproduction by parthenogenesis and bisexual reproduction. It is found in some aphids.

heterograft *See* graft.

heterogynous *See* Cynipidae.

heterokaryon (heterocaryon) Fungal mycelium or hypha that contains nuclei of two or more genetic types.

heterokont Having flagella of different lengths.

heterologous Applied to an antigen and antibody that do not correspond, so that one is said to be heterologous with respect to the other. The term may also be used to refer to a graft originating from a donor of a species different from that of the host.

heteromeric *See* dimer.

heteromerous 1 Composed of units (e.g. cells) of different types. 2 Having unequal numbers of parts. 3 Layered, as in a lichen thallus in which the algae are confined to a distinct layer.

Heteromi Group of deep-sea fish now included in the order Notacanthiformes.

heteromorphic Literally, differing in form, and applied to: (a) phases/stages of organisms in which there is alternation of generations, particularly in algae where generations are vegetatively dissimilar; and (b) a chromosome pair that have some homology but that differ in size or shape, e.g. the X and Y sex chromosomes.

Heteromyidae (kangaroo rats, pocket mice, spiny mice; order Rodentia, suborder Sciuromorpha) Family of nocturnal, burrowing rodents, most of which are adapted for jumping, having elongated hind feet and usually a long, haired tail. The limbs are pentadactyl and the forelimbs bear powerful claws. Heteromyidae are distributed throughout the New World from British Columbia to the northern part of S. America. There are many species.

Heteronemertini (phylum Nemertini, subclass Anopla) Order of elongate, nemertinid worms which possess double-layered body muscles. A ciliated epidermis and a highly developed dermis are present.

heterophylly The state of having leaves of different shapes on the same plant.

Heteropneustidae (airsac catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater fish which possess a single dorsal fin, a very long anal fin, a rounded tail-fin, four pairs of barbels around the mouth, and (especially in the males) poisonous spines in the dorsal and pectoral fins (which are dreaded by local fishermen). The long air sac extending from the gill chamber is also typical, and gives rise to the alternative name, 'Saccobranchidae'. A few species occurring in SE Asia, are sometimes kept in aquariums. *Heteropneustes fossilis* grows to 70 cm.

Heteropoda venatoria (huntsman spider) *See* Sparassidae.

Heteroptera (plant bugs, water bugs; class Insecta, order Hemiptera) Suborder of bugs in which the head capsule is continuous ventrally behind the mouthparts. Stink glands are almost always present. *See* Aradidae; assassin bug; Belostomatidae; *Cimex lectularius*; Cimicidae; Coreidae; Corixidae; Gerridae; kissing bug; Lygaeidae; Miridae; Nepidae; Notonectidae; *Oeciacus hirundinis*; Pentatomidae; Pyrrhocoridae; Reduviidae; Saldidae; and Tingidae.

heterosis (hybrid vigour) The increased vigour of growth, survival, and fertility of hybrids, as compared with the two homozygotes. It usually results from crosses between two genetically different, highly inbred lines. It is always associated with increased heterozygosity.

Heterosomata Older name for the order Pleuronectiformes (flatfish).

Heterospathe (family Palmae) Genus of palms in which the leaves are pinnate with the crown-shaft. They are monoecious. There are about 40 species, found in Malesia, Australia, and the W. Pacific islands.

heterosphere The layers of the atmosphere, above 80 km altitude, through which the chemical composition of the air changes markedly with height, principally as a result of oxygen dissociation. *Compare* homosphere.

heterospory Production of spores of two different types on the same plant. Microspores are small and numerous; from these the male gametophytes develop. Megaspores, within which the female gametophytes develop, are larger and fewer. *Compare* homospory; *see also* microsporangium.

Heterostraci Alternative name for Pteraspida, an order of fossil jawless vertebrates (Agnatha).

heterostyly Polymorphism amongst angiosperm flowers that ensures cross-fertilization through pollination by visiting insects. Flowers have anthers and styles of different lengths; usually the anthers of one morph are at the same level as the stigmas of another. A well-known example is the pin-eyed (long style) and thrum-eyed (short style) forms of *Primula vulgaris* (primrose).

heterothallic Applied to a fungus that is self-sterile. Sexual reproduction requires the participation of two thalli of compatible mating types.

Heterotrichida (subclass Spirotrichia) Order of ciliate protozoa in which the body cilia are either uniformly arranged or absent. The cell body is often large, e.g. in *Spirostomum* it is up to 3 mm in length. There are eight families, and many genera, found in freshwater and marine habitats, and as commensals in the intestines of animals.

heterotroph Organism that uses organic compounds as its main or sole source of carbon. *Compare* autotroph.

heteroxenous *See* heteroecious.

heterozygosity Presence of alleles (different forms of a given gene) at a particular gene locus. Heterozygosity provides a measure of the genetic variation, either in a population (the frequency of individuals heterozygous at a particular locus), or in an individual (the proportion of gene loci that are heterozygous).

heterozygote Diploid or polyploid individual that has alleles (different forms of a given gene) at at least one locus. Its phenotype is often identical to that of an individual that has one of these alleles in the homozygous state. (For example, the phenotype of A_1A_2 may be identical to that of A_1A_1, but different from that of A_2A_2.) If so, that allele (A_1) is said to be dominant over the other (A_2), which is said to be recessive. When there exist only two alleles of a gene and when one of these is dominant over the other, one may use a lower-case letter for the recessive allele, e.g. one may write *Aa* rather than A_1A_2. However, alleles are not always dominant one over another; and often there are more than two alleles at a given locus, especially in polyploids. Because it has two or more different alleles at a given locus, a heterozygote does not breed true.

heterozygous advantage *See* genetic polymorphism.

Hevea (family Euphorbiaceae) Small genus of trees whose bark contains latex. The leaves are trifoliate. The flowers are unisexual, male and female being in the same panicle. The fruit is an explosively dehiscent capsule. Rubber (or para rubber) is *H. brasiliensis*, now planted widely in the Far East. There are 12 species, found in the rain forest of Amazonia.

Hexacorallia Alternative name for the anthozoan subclass Zoantharia.

Hexactinellida (Hyalospongea; phylum Porifera) Class of sponges whose skeleton is composed of mainly six-rayed, siliceous spicules. Organic fibres do not occur. The body has a leucon structure. They are marine, deep-water sponges and first appeared in the Lower Cambrian.

hexad *See* crystal symmetry.

Hexagrammidae (greenling; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish which have a fairly robust body, a long and low dorsal fin divided by a deep notch, a truncate tail-fin, and rounded pectorals. Several species, e.g. *Hexagrammos decagrammus* (kelp greenling), 50 cm, and *Ophiodon elongatus* (lingcod), 1.5 m, are popular sport fish. There are about 21 species, found in coastal regions of the N. Pacific.

Hexagrammos decagrammus (kelp greenling) *See* Hexagrammidae.

Hexanchidae (cow shark; class Chondrichthyes, subclass Elasmobranchii, order Hexanchiformes) Small family of marine sharks, typically with a single, spineless dorsal fin, an anal fin, and six or seven gill slits, the gill slits not being continuous across the throat. There are about five species,

distributed worldwide, e.g. *Notorynchus maculatus* (sevengill shark) is found in the Pacific basin.

Hexanchiformes Order of marine sharks possessing six or seven gill slits, and one dorsal fin, and having the anal fin present. It includes the families Chlamydoselachidae and Hexanchidae.

hexaphosphoinositol *See* phytic acid.

hexaploidy *See* polyploidy.

Hexapoda *See* Insecta.

hexaster Applied to one of the small flesh spicules of a poriferan (sponge) if it takes the shape of six rays emanating from a central point.

Hexasterophora (phylum Porifera, class Hexactinellida) Subclass of sponges in which the small, flesh spicules occur as hexasters.

hexose Monosaccharide sugar containing six carbon atoms, e.g. glucose, fructose, and galactose.

hexose-monophosphate shunt (pentose phosphate shunt) Metabolic pathway, alternative to that of glycolysis, of carbohydrate interconversion: hexose-6-phosphate is converted into pentose phosphate and carbon dioxide. The principal functions of the pathway are the production of deoxyribose and ribose sugars for nucleic-acid synthesis; the generation of reducing power in the form of NADPH for fatty-acid and/or steroid synthesis; and the interconversion of carbohydrates. Parts of the pathway are involved in the Calvin cycle in photosynthesis.

Hibbertia (family Dilleniaceae) Genus of xeromorphic shrubs, sometimes climbing, some with phylloclades, which have a curious range, believed to indicate former continental connections. There are 100 species, occurring in Madagascar, New Guinea, Australia, New Caledonia, and Fiji.

hibernal In the winter. The term is used with reference to the six-part division of the year used by ecologists, especially in relation to studies of terrestrial and freshwater communities. *Compare* aestival; autumnal; prevernal; serotinal; and vernal.

hibernation Strategy for surviving winter cold, characteristic of some mammals. Metabolic rate is reduced to a minimum and the animal enters a deep sleep, surviving on food reserves stored in the body during the favourable summer period. *Compare* aestivation.

Hibiscus (family Malvaceae) Genus of trees and shrubs, whose showy flowers have a prominent stamen tube. They are bird-pollinated. Several are widely cultivated, especially *H. rosa-sinensis*. Okra is the mucilaginous young fruit of *H.* (*Abelmoschus*) *esculentus*. There are 300 species, with a pantropical distribution.

hickory *See Carya*.

hiddenite *See* spodumene.

hidden-necked turtles *See* Cryptodira; and Pelomedusidae.

hide beetle *See* Dermestidae.

hierarchical and non-hierarchical classification methods The grouping of individuals by a series of subdivisions or agglomerations to form a characteristic 'family tree' or dendrogram of groups. Alternatively classification may be non-hierarchical, i.e. proceeding not by an organized series of progressive joinings or subdivisions, but instead achieving groupings by a series of simultaneous trial-and-error clusterings (successive approximation) until an optimum and stable pattern is found. A possible scheme, for example, is to select at random a number of starter individuals, equal to the number of groups required, and to which other individuals are added or from which they are removed according to their characteristics and the classificatory philosophy used (that of seeking to minimize internal group heterogeneity, or of seeking to maximize differences between groups). The chief advantage of hierarchical over non-hierarchical methods is the clarity with which the routes to the final groupings may be followed, facilitating explanation of those groups. However, since most hierarchical classifications either dichotomize or pair at each division or join, natural clustering patterns may be distorted or poorly represented. Hierarchical classifications are also more likely to be unduly affected by irrelevant background information.

hierarchy 1 Form of organization in which certain elements of a system regulate the activity of other elements. 2 Form of social organization in which individuals, or groups of individuals, possess different degrees of status, affecting feeding, mating behaviour, etc.

high arctic tundra The northern-most sector of the tundra, distinguished by a lack of complete vegetation cover, except in the most favoured, and usually very restricted, habitats. Such tundra vegetation as exists tends to be marshy, with little but lichen in the more exposed situations.

high cockscomb (*Anoplarchus purpurescens*). *See* Stichaeidae.

higher categories In taxonomy, categories higher than species, which are defined arbitrarily according to observed similarities among species, and which provide a useful hierarchical framework by which organisms may be described succinctly.

higher fungi Fungi belonging to the subdivisions Ascomycotina, Basidiomycotina, and Deuteromycotina.

high forest Forest comprising trees of all ages from which it is planned to obtain a crop of timber. The term does not apply to underwood or coppice. It applies equally whether the trees were planted by humans, were self-sown, or were derived from coppice stools. The trunks of the trees remain unbranched up to considerable heights, and grow in strong competition with each other for light. As is implied by this, the density of trees is relatively high.

Hiller peat-borer *See* peat-borer.

hill fog General term denoting low cloud that covers high ground.

hillock tundra Poorly drained, marshy tundra with numerous hummocks about 25 cm high, which give

better drainage and may therefore support heathy plants and lichens. A range of microhabitats is provided by the hummocks and these are exploited by plants with different ecological requirements.

hillstream loach *See* Homalopteridae.

hilum 1 The point on a fungal spore at which it was attached to its sporophore. 2 The scar on a seed that marks the point at which it was attached to the plant.

Himantandraceae Family of aromatic trees with fimbriate, peltate scales, in which the leaves are simple, and without stipules. The flowers have two fused sepals, four petals, and numerous stamens and carpels. The fruit is a globose syncarp. Himantandraceae are close to Magnoliaceae. There is one genus, *Galbulimima*, with three species, occurring in E. Malesia.

Himanthaliaceae (order Fucales) Family of brown seaweeds, which includes a single genus, *Himanthalia*. The plant lives for two years. During the first year a stalked, disc-like thallus is formed: this measures several centimetres across. In the second year 1–4 long, strap-like branches grow from the disc, and these bear the conceptacles within which gametes are formed. There is one British species, *H. elongata* (sea-thong), found at or near the low-water mark on exposed shores.

Himantholophidae (football fish; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of deep-sea fish with an almost rotund ('football') body, short fins, the dorsal and anal fins close to the tail, minute eyes, a large mouth, and a well-developed illicium ('fishing rod') above the mouth. Growing to about 60 cm, *Himantholophus groenlandicus* can be found at 100–1000 m depth. There are four species, distributed worldwide.

Hiodon tergisus (mooneye) *See* Hiodontidae.

Hiodontidae (mooneye; class Osteichthyes, subclass Actinopterygii, order Osteoglossiformes) Small family of freshwater, herring-like fish which have a single dorsal fin positioned behind the ventral fins. The eyes are large, and the jaws bear small teeth ('toothed herring'). The larger of the two species is *Hiodon tergisus* (mooneye), 38 cm, a popular sport fish in Canada. The two species are found only in the eastern half of Canada and the USA.

Hippoboscidae (class Insecta, order Diptera, suborder Cyclorrapha) Family of aberrant flies which lack wings and are usually flattened dorsoventrally. The head is sunk into a groove in the thorax, and the mouthparts are directed forwards, as a proboscis adapted for piercing. The antennae are inserted into a depression, and the eyes are round or oval. The adults are 'tough-skinned', an adaptation to life as ectoparasites of large mammals. One of the most familiar is *Hippobosca equina* (forest fly), which feeds on the blood of horses and cattle. Members of the genus *Ornithomyia* are ectoparasites of birds. Larvae are produced by the females in a mature state, and they pupate almost immediately. Some, e.g. *Lepoptena* species, are winged as a means of dispersal, but cast their wings once a suitable host is found. More than 200 species are known so far.

hippocampal commissure Band of nerve fibres which connect the hippocampal regions of the left and right cerebral hemispheres.

Hippocampus hippocampus (sea horse) *See* Syngnathidae.

Hippocastanaceae Family of trees or shrubs with opposite, palmately compound leaves without stipules, and large terminal panicles of showy, irregular flowers. The flowers have usually five sepals and four petals; and a superior ovary that ripens to a large, thick-walled capsule containing one or two large, leathery, glossy, nut-like, inedible seeds. Flowers are zygomorphic, with a disc. Winter buds have big scales. There are two genera. *Aesculus* (deciduous), with about 25 species, occurs in the northern temperate zone, and *Billia* (evergreen) in tropical C. and S. America. *A. hippocastanum* (horse chestnut), is often grown for ornament. *Aesculus* also includes the buckeyes of N. America.

Hippocrateaceae Group of plants that were formerly regarded as a separate family, but are now included in the family Celastraceae.

Hippolais (warblers; family Sylviidae) Genus of grey, brown-green, and yellow warblers which have distinctive, peaked heads, and square-ended tails. They have loud imitative songs. They inhabit woodland, gardens, and scrub; feed on insects; and nest in bushes and trees. There are six species, all migratory, found in Europe, Asia, and Africa.

Hippomorpha (superorder Mesaxonia, order Perissodactyla) Suborder of horse-like animals comprising the extinct families Palaeotheriidae and Brontotheriidae and the extant family Equidae, which includes existing horses, asses, and zebras, and their extinct relatives.

Hippopotamidae (hippopotami; order Artiodactyla, suborder Suiformes (Suida)) Family of large, amphibious artiodactyls descended from the anthracotheres, which appear in the fossil record for the first time in sediments of Upper Pliocene age. Now confined to Africa, during the Pleistocene they were widespread in the warmer regions of the Old World. In modern forms the dentition is complete except for the outer incisors. The eyes are small and set high on the skull, and the nostrils can be closed. Each limb possesses four digits, all of which are functional. There are two monotypic genera, *Hippopotamus amphibius* (common hippopotamus) and *Choeropsis liberiensis* (pygmy hippopotamus).

hippopotamus *See* Hippopotamidae.

Hipposideridae (Old World leaf-nosed bats; order Chiroptera, suborder Microchiroptera) Family of insectivorous bats in which the nose has a prominent leaf, the nostrils opening at the centre of a disc. The ears are pointed, and in some species joined; they are independently mobile, with an antitragus but no tragus. The tail extends to the edge of the uropatagium. There are many species, distributed throughout the Old World tropics.

Hippuridaceae Family of one genus and species, *Hippuris vulgaris* (mare's-tail), which is a perennial aquatic herb with linear leaves in whorls. It is superficially like *Equisetum*, but is a flowering plant with inconspicuous flowers, each of one stamen and an inferior ovary, in the axils of those leaf-whorls that are emergent from the water. It is distributed in Europe, W. Asia, and N. Africa.

Hippuris vulgaris (mare's-tail) *See* Hippuridaceae.

Hippuritoida (phylum Mollusca, class Pelecypoda) Extinct order of large, epifaunal, cemented pelecypods which had markedly unequal valves, and thick, conical shells. Many resembled large solitary corals. They had pachydont dentition, consisting of very large, heavy teeth, and some were edentulous. A ligamental groove or ridge was present, and they had a dimyarian musculature. Some lived as solitary individuals, but most lived communally, and were important reef-builders during the Cretaceous. They first appeared in the Middle Silurian, and died out at the end of the Cretaceous.

Hirandapus *See Chaetura*.

Hirudinea (leeches; phylum Annelida) Class of annelid worms in which segmentation is less obvious than in most annelids. Suckers are generally present at the anterior and posterior ends but bristles are normally absent. The nervous system is well developed. All are hermaphrodites. They occur in marine, freshwater, and terrestrial habitats, and some forms are bloodsuckers.

hirundines *See* Hirundinidae.

Hirundinidae (swallows, martins, hirundines; order Passeriformes) Family of small, brown, dark-blue, or dark-green birds, many with white under-parts, which have short bills with a broad gape, long and pointed wings, and a medium to long tail which is often strongly forked. The legs are short, and feathered in some species. Hirundinidae inhabit open areas and are aerial insectivores. They nest in cavities in trees and rocks, in burrows, or in mud nests on ledges and buildings. There are 17–19 genera, with 77–81 species, found worldwide, many of them migratory.

Hirundo (swallows, martins; family Hirundinidae) Genus of mainly blue-black swallows, many of which have white or chestnut under-parts. Their nests are made of mud, placed in a variety of sites. *H. rustica* (swallow, or barn swallow) is found in both Old and New Worlds. There are 20–24 species, found worldwide.

Hirundo rustica (swallow, barn swallow) *See Hirundo*.

hispid Having short stiff hairs or bristles.

histamine Compound formed by the decarboxylation of histidine and released principally by mast cells during an allergic reaction, in mediating inflammation. It causes the dilatation of blood vessels, the increased permeability of capillaries, and the contraction of smooth muscle.

Histeridae (class Insecta, order Coleoptera) Family of hard, shiny beetles, 1–16 mm long, with a convex ventral surface. They are generally black or metallic in colour. The last two abdominal segments are exposed. The antennae are clubbed and elbowed. The tibiae are expanded and toothed. When the beetles are disturbed, the legs and antennae are withdrawn into grooves on the under-side. Adults and larvae live in dung and carrion, where they feed on insect larvae. Some species live in birds' nests, while others are associated with the nests of ants and termites. There are 2500 species.

histic epipedon Surface soil horizon, not less than one metre in depth, high in organic carbon, and saturated with water for some part of the year. *See also* humus (2).

histidine Basic, polar amino acid that contains an imidazole group.

Histiopteridae *See* Pentacerotidae.

histochemistry The study of the chemistry of tissues and cells, using combined techniques from histology and biochemistry.

histocompatibility genes The genes for antigens that are responsible for the acceptance or rejection of foreign bodies in the form of transplanted tissues (grafts).

Histomonas Genus of parasitic protozoa, classified sometimes in the order Rhizomastigida, sometimes in the order Trichomonadida. *H. meleagridis* is parasitic in the caeca and liver in a range of gallinaceous birds, and causes the disease of turkeys known as blackhead.

histone One of a group of basic, globular, simple proteins that have a high content of the amino acids arginine and lysine. Histones form part of the chromosomal material of eukaryotic cells and appear to play an important, but as yet incompletely understood, role in gene regulation.

histoplasmosis (Darling's disease) Disease of humans and other animals, caused by the fungus *Histoplasma capsulatum*. The disease usually takes the form of a mild, self-limiting infection of the respiratory tract, but it may become a severe, sometimes fatal, systemic condition.

Histosols Organic soils, an order of the USDA Soil Taxonomy, composed of organic materials. Histosols must have a thickness of more than 40 cm when overlying unconsolidated mineral soil, but may be of any thickness when overlying rock.

hive Artificial nest provided by beekeepers for honeybees (*Apis mellifera* in the West and in Africa; *A. cerana* in parts of Asia), and for some stingless bees (*Melipona* species) in S. America.

hoarding Storage by an animal of some commodity, usually of food, in a central cache or in specific locations throughout a range.

hoar frost Deposit of patterned—'feathers', 'needles', 'spines', etc.—ice crystals on surfaces chilled by radiation cooling. The feature is seen particularly well on vegetation. The ice is derived from the sublimation on surfaces of water vapour, as well as from frozen dew.

hoatzin *See* Opisthocomidae.

Hodotermitidae (order Isoptera) Family of lower termites. They feed on damp wood, except for the subfamily Hodotermitinae (harvester termites), which feed on vegetation. The Hodotermitinae forage above ground, sometimes in daylight; unlike other termites, they have well-developed eyes. There are 30 species, found mainly in the Old World tropics.

Hodotermitinae *See* Hodotermitidae.

hogback (hog's back) Narrow, symmetric ridge, underlain and controlled by a resistant bed dipping at some 40° or more. It is a limiting case of a cuesta.

hog cholera (swine fever) Disease which appears to affect only pigs. The disease is highly contagious; symptoms include fever, vomiting, diarrhoea, and skin haemorrhages. The mortality rate is usually very high. It is caused by a virus of the Togaviridae.

hog plum *See Spondias*.

hog's back *See* hogback.

Holarctica A formerly unified, circumpolar biogeographic region, embracing what are now N. America, Europe, and Asia (i.e. Laurasia). The legacy of this region is attested to by the great floral and faunal similarities between the three northern continents.

Holasteroida (class Echinoidea) Order of irregular echinoids in which the apical system is elongated, but not disjunct as in the Disasteroida. In the plastron, the labral plate is followed by a single, large plate, and a varying number of plates in a single column. The Holasteroida first appeared in the Lower Cretaceous.

Holaxonia (order Gorgonacea) Suborder of octocorals, with a distinct central axis of horny material either alone or more or less heavily permeated with a calcareous substance. The suborder contains 11 families, with about 100 genera.

holdfast Differentiated structure in a seaweed or other alga, the function of which is to attach the thallus to a substrate, e.g. rocks, other plants, or shells. A holdfast may be superficially root-like, or may be discoid and sucker-like.

Holectypoida (class Echinoidea) Order of irregular echinoids, with ambulacra that are narrower than the interambulacra, lateral flanges on the teeth, and the periproct usually on the lower (sometimes the posterior) surface. They first appeared in the Lower Jurassic, and diversified in the Cretaceous, but only one family has survived.

holistic (holological) Relating to the whole. In ecology, the term refers to the 'black box' approach to ecosystem studies, which attempts to understand ecosystems by studying the inputs to and outputs from them rather than examining the component parts of the system. *Compare* merological approach.

Holling's disc equation Measure of the functional response of predators to increased prey density. The equation is based on laboratory experimental data simulating predation. A human predator gathers discs (prey) from boards with different 'prey' densities. In theory, the efficiency with which the predator consumes the prey should decline as the prey density increases, due to extra time spent handling the prey. Thus the relationship between prey density and numbers consumed by predators is not a straight line but a curve. This relationship was first summarized mathematically by C. S. Holling (1959) as $y = T_t ax/(1-abx)$ where y is the number of discs removed, x is the disc density, T_t is the total experimental time, a is a constant describing the probability of finding a disc at a given density, and b is the time taken to pick up a disc.

hollow phase Stage in the cyclical pattern of vegetation change in grassland, at which a hollow forms from the erosion of an old grass hummock during the degenerate phase. Colonization of the bare soil by grass seedlings triggers the development of a new hummock. *Compare* building phase; mature phase; and degenerate phase.

holly (*Ilex aquifolium*) *See* Aquifoliaceae.

hollyhock (*Althaea rosea*) *See Althaea*; and Malvaceae.

Holobasidiomycetidae (class Hymenomycetes) Subclass of fungi in which the basidia are aseptate. There are six orders. The subclass includes obligate parasites of higher plants, as well as facultative parasites and saprotrophs.

holocarpic Applied to a fungus in which the whole thallus differentiates to form one or more reproductive structure.

Holocene Epoch that covers the last 10 000 years. It is often referred to as Recent or Post-Glacial.

holocentric Applied to chromosomes with diffuse centromeres such that the properties of the centromere are distributed over the entire chromosome.

Holocentridae (squirrelfish; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Large family of tropical- to temperate-water, marine fish, all species of which have large eyes, long dorsal fins which are deeply notched, spiny edges on the opercles, and strongly developed anal-fin spines. The tail-fin is deeply forked. They are mostly nocturnal fish, and the body has a reddish colour. One of the more common W. Atlantic species is *Holocentrus ascensionis* (squirrelfish) which may grow to about 35 cm. There are about 70 species, distributed worldwide.

Holocentrus ascensionis (squirrelfish) *See* Holocentridae.

Holocephali Often ranked as a subclass, the Holocephali comprise a group of peculiar, shark-like fish, including both living and fossil species. They are characterized by a cartilaginous body; large eyes; large, wing-like pectoral fins; a whip-like tail; a scaleless skin; and the common gill chamber covered by an operculum. *See also* Chimaeriformes.

holoenzyme Entire conjugated enzyme, comprised of a protein component or apoenzyme, and its non-protein or prosthetic group.

hologamete In Protista, a gamete formed from the entire cell body.

holological *See* holistic.

holophyletic Of a taxon: including all descendants of the common ancestor. The term is a special case of 'monophyletic'.

holoplankton Zooplankton organisms that are planktonic throughout their life cycles. *Compare* meroplankton.

holoptic *See* Simuliidae.

Holostei Group of marine and freshwater bony fish including many fossil species. Recently ranked as an infraclass, the Holostei include the families Semionotidae, Lepisosteidae, and Amiidae.

holothuroid (sea-cucumber) *See* Holothuroidea.

Holothuroidea (sea-cucumbers; subphylum Echinozoa) Class of worm-like echinoderms which may be free-living or attached. The mouth, surrounded by variably branched tentacles, is at one end of the elongate body, the anus at the other. The calcitic skeleton is not rigid, being reduced to small sclerites (or spicules) of very variable shape: hooks, anchors, rings, and plates. Fossil spicules of sea-cucumbers are first encountered in rocks of Ordovician age.

Holotrichia (class Ciliatea) Subclass of ciliate protozoa, which generally have a simple, uniform distribution of cilia on their cells. The subclass includes a wide range of forms. There are seven orders, with numerous genera.

holotype *See* type specimen.

holozoic Applied to the method of feeding in which nutrients are obtained by consuming other organisms.

homalodotheres *See* Notoungulata.

Homalopteridae (hillstream loach; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish which have a slender body; a subterminal mouth; three or more pairs of barbels around the mouth; a single dorsal fin; and large, rounded pectoral and pelvic fins. They are bottom-dwelling fish inhabiting fast-flowing mountain streams. There are about 87 species, found in tropical Asia.

Homalorhagida (phylum Aschelminthes, class Kinorhyncha) Order of aschelminth worms, in which the head is covered on retraction by a series of body plates on the third segment.

Homalothecium (order Hypnobryales) Genus of medium-sized to large mosses, in which the stems are irregularly to subpinnately branched. The leaves are triangular, tapering from the base to a long point at the tip; a single nerve extends about three-quarters of the way up each leaf. It is a small genus, with about eleven species, found in Europe, Asia, Africa, and America. *H. sericeum* (formerly *Camptothecium sericeum*) is a prostrate, creeping plant which forms extensive mats on walls, rocks, trees, roofs, etc.; it is yellowish-green to brown, with a characteristic silky sheen especially noticeable when the plant is dry. *H. lutescens* (formerly *C. lutescens*) is not prostrate; it forms loose tufts, is yellowish-green in colour, and is found chiefly on calcareous soil.

Homalozoa (phylum Echinodermata) Extinct subphylum whose members have no trace of radial symmetry. The theca is depressed and asymmetrical. Homalozoa are known from Middle Cambrian to Middle Devonian rocks.

Homarus americanus (giant American lobster; subclass Malacostraca, order Decapoda) Species of large lobsters in which individuals weigh up to 22 kg and attain lengths of 60 cm. Their large chelipeds contain as much meat as the abdomen. It is a nocturnal species, feeding on molluscs, carrion, and vegetation; and individuals may live for up to 50 years. Caught commercially in pots and traps, it is important along the north-east coast of the USA.

Homarus gammarus (common lobster, European lobster; subclass Malacostraca, order Decapoda) Species of lobster which is similar to *H. americanus* (giant American lobster) but smaller, being only 30–50 cm long. Trapped commercially in pots or kreels, it prefers rocky sea-beds in shallow waters, although it moves to deeper water during the winter. It feeds nocturnally, cracking open molluscs with its large chelipeds and also taking carrion. The chelipeds on one side are much larger than those on the other. Blue mysis larvae hatch from the eggs after nearly one year and are 7 mm long. There are three mysis larval stages and a lobster-shaped postlarval stage. After many moults, maturity is reached in the sixth year. Thereafter moulting is annual.

homeostasis *See* homoeostasis.

homeotherm *See* homoiotherm.

home range Area within which an animal normally lives. The boundaries of the range may be marked (e.g. by scent marking), and may or may not be defended, depending on species.

homing Return by an animal to a particular site that is used for breeding or sleeping. The term may apply to the return of an animal to its nest after foraging, or to seasonal migrations between breeding and feeding grounds.

Hominidae (order Primates, suborder Anthropoidea, superfamily Hominoidea) The mammalian family that includes humans and immediately ancestral forms now extinct. Its members are distinguished from the apes (Pongidae) by the possession of a much larger brain, in which the frontal and occipital lobes are especially well developed, allowing more complex behaviour including communication by speech; by a fully erect posture facilitated by the positioning of the foramen magnum beneath the skull so that the head is held upright; by a bipedal gait; and by the slow rate of post-natal growth and development, which favours complex social organization and the emergence of distinct cultures. The family includes the genera *Paranthropus*, *Australopithecus* (but *see* australopithecines), and *Homo*. Whether a possible ancestral genus *Ramapithecus* should also be included in this family or with the apes is a matter

for debate. *Ramapithecus* appeared about 14 million years ago, whereas the oldest undoubted hominid fossils are about 3.5 million years old. By many authors the great apes are also included in Hominidae. There is one surviving species, *Homo sapiens sapiens* (humans).

Hominoidea (order Primates, suborder Anthropoidea) Superfamily comprising the Hylobatidae (gibbons), Pongidae (great apes), and Hominidae (humans). The latter two families are believed to be descended from a common stock of 'great apes' which diverged to form distinct Asian and African lines, the African line dividing again 4–6 million years ago into the African apes and the hominids. Some authorities hold that the hominids and African apes should be grouped together and the orang utan separately; or else, that all great apes should be included in the Hominidae. The hominoids lack tails and cheek pouches; have catarrhine nostrils and opposable thumbs (reduced in some species); and differ from the Cercopithecidae in having less specialized dentition, a vermiform appendix in the gut, and larger heads, longer limbs, and wider chests, which some authorities believe they inherited from ancestral brachiating forms. Today only the Hylobatidae are specialized brachiators.

Homo (order Primates, suborder Anthropoidea, superfamily Hominoidea, family Hominidae) The genus to which humans belong. *Homo habilis* ('handy man'), dating from about 1.9 million years ago, was until recently regarded as the oldest member of the genus, but new hominid fossils from E. African sites are thought by some authorities to be of even older representatives, dating from over 3 million years ago; and members of the genus *Australopithecus* are often included in *Homo*. *See H. africanus; H. erectus; H. habilis;* and *H. sapiens*.

Homo africanus The earliest species of our own genus, formerly called 'gracile australopithecines'. The species lived in Africa about 2.5–3.5 million years ago.

homoallelic Applied to allelic mutants of a gene that have different mutations at the same site; as opposed to heteroallelic mutants, which have mutations at different sites with the one gene. Recombination between heteroalleles can yield a functional cistron; recombination between homoalleles cannot.

Homoalozoa (phylum Echinodermata) Subphylum of echinoderms whose members lack radial symmetry and have a fundamentally asymmetrical body. It includes the classes Homoiostelea, Homostelea, Machaeridia, and Stylophora, all of which are restricted to Palaeozoic rocks.

homocercal tail In fish, a tail in which the last vertebra adjoins modified bony elements (the urostyle and hypurals) which support the fin rays in such a manner that the tail-fin outwardly appears symmetrical. The homocercal tail-fin is typical of the higher bony fish.

homodimer Protein that is made up of two identical polypeptides paired together; as opposed to a heterodimer, in which the polypeptides are not identical.

homodont Possessing teeth all of which are of the same form.

homoeostasis (homeostasis) Tendency of a biological system to resist change and to maintain itself in a state of stable equilibrium.

Homo erectus The predecessor of humans. *H. erectus* lived in Africa and Asia about 2–0.5 million years ago. It stood about 1.5 m tall and had a cranial capacity about 25% less than that of *H. sapiens*. Apart from the skull, however, the skeleton of *H. erectus* was very similar to that of *H. sapiens*. The standardized tools made by some *H. erectus* are categorized as Acheulean.

homogametic sex The sex that has sex chromosomes that are similar in morphology (for example, XX); and hence the sex that produces only one kind of gamete with respect to the sex chromosomes. *Compare* heterogametic sex.

homogeneous nucleation Spontaneous condensation or freezing of water in the atmosphere in the absence of substances to act as nuclei. This is most likely in supercooled air below −40 °C.

homograft *See* graft.

Homo habilis Hominid ('handy man') who lived in Africa about 1.75 million years ago (late Pliocene to early Pleistocene), and who may have given rise to *H. erectus*, although known fossils are too late for this. What are claimed to be earlier fossils of the genus *Homo*, over 3 million years old, are now known from E. Africa. The cranial capacity, averaging 650 cm^3 was intermediate between *H. erectus* and the earlier 'australopithecines'.

homoiomerous Uniform in structure; composed of units (e.g. cells) of all the same type. The term is applied to a lichen thallus in which the algae are distributed uniformly throughout the thallus.

homoiotherm (endotherm, homeotherm) Organism with a mechanism for the regulation of internal body temperature, which is maintained at a relatively constant level. Higher vertebrates (i.e. birds and mammals) are homoiothermic ('warm-blooded'). *Compare* poikilotherm.

homokaryon (homocaryon) Fungal mycelium or hypha in which all the nuclei are genetically identical.

homologous Term applied to organs or chromosomes. An organ of an animal is said to be homologous with that of another when both are thought to have the same evolutionary origin, although their functions may differ widely. Homology is generally deduced from similarity of structure and/or position of the organ relative to other organs, seen particularly during embryonic development; an example is the ear ossicles of a mammal, which are homologous with certain bones involved in the articulation of the jaw in fish. Homologous chromosomes are those which contain identical linear sequences of genes, and which pair during meiosis. Each homologue is therefore a duplicate of one of the chromosomes contributed

by one of the parents; and each pair of homologous chromosomes is normally identical in shape and size. *Compare* heterologous.

homology The basic similarity of a particular structure in different organisms: it usually results from their descent from a common ancestor.

homomeric *See* dimer.

homonym In nomenclature, one of two or more separately published names for the same taxon or identical names for different taxa.

Homoptera (class Insecta, order Hemiptera) Suborder of bugs, in which the head capsule is not continuous ventrally behind the mouthparts. All homopterans are plant feeders. In some the forewings are membranaceous like the hindwings, but in others they are of a more leathery texture, and are then known as tegmina (sing. 'tegmen'). *See also* Aleyrodidae; Aphididae; Cercopidae; Cicadellidae; Cicadidae; Cixiidae; Coccidae; Delphacidae; Flatidae; Fulgoridae; Lacciferidae; Membracidae; Peloridiidae; Phylloxeridae; and Psyllidae.

Homo sapiens neanderthalensis 'Neanderthal man' is generally regarded as a subspecies of modern humans. The subspecies inhabited the periglacial regions of N. Europe between about 100 000 and 35 000 years ago. Although shorter and sturdier than modern men, the cranial capacity was about the same. Even so, the classic Neanderthal skull possessed a heavy brow-ridge above high, circular eye sockets; the forehead was flattened, and the chin weak or absent altogether. The back of the braincase was also swollen into a so-called 'occipital bun'. Neanderthal man was responsible for the stone tools and other artefacts that constitute the Mousterian culture.

Homo sapiens sapiens Cro-Magnon, or fully modern man of European type. The subspecies appeared in western Europe about 35 000 years ago, and either displaced or absorbed the Neanderthals, who inhabited the tundra environments which were prevalent then. It is not known where *H. sapiens sapiens* developed after the subspecies diverged from *H. sapiens neanderthalensis* during the last interglacial, but other modern human types are known from S. Africa at about 60 000 years ago, and from Australia at the same time as the Cro-Magnons inhabited Europe. Cro-Magnon peoples were responsible for cave art and flint blades of the Upper Palaeolithic cultures.

Homosclerophorida (class Demospongiae, subclass Tetractinomorpha) Order of sponges that have a differentiated leucon structure. Some lack skeletons and possess a thin dermis. A cortex is present in more advanced forms. The larvae are amphiblastulae.

homosphere Atmospheric layer from the Earth's surface to approximately 80 km altitude, where the relative proportions of the various gaseous constituents, excluding water vapour, remain almost constant. *See also* heterosphere.

homospory Production by a cryptogamic plant of spores that are all of uniform type and size, and from which develop gametophytes which usually contain both male and female cells. *Compare* heterospory; *see also* microsporangium.

homothallic Applied to a self-fertile fungus, i.e. one in which sexual reproduction can occur in a single thallus.

homozygosity The presence of identical alleles at one or more loci in homologous chromosomal segments.

homozygote Individual having the same genes at one or more loci. The phenotype of the genes for a particular locus will always be expressed since the two genes at the homologous loci are identical. An individual will breed true at those homologous loci that are homozygous.

honey Nectar collected by bees from flowers, and partly digested so that the complex sugars are broken down to simpler ones. It is concentrated by the evaporation of water, and also contains traces of gums, pollen, minerals, and enzymes. It is one of the principal foods of growing bee larvae, the other being protein-rich pollen. Honey is also eaten by adult bees, and is an energy-rich food which fuels their foraging trips.

honey badger (ratel, *Mellivora capensis*) *See* Mustelidae.

honeybee Eusocial member of the family Apidae, whose colonies are perennial. The term is usually restricted to the four species of *Apis* (*A. cerana*, *A. dorsata*, *A. indica*, and *A. mellifera*), but is sometimes used to include the stingless bees, *Melipona* and *Trigona*, which also store large amounts of honey.

honey buzzards *See Pernis*.

honeycomb Double-sided sheets of hexagonal wax cells built by honeybees (*Apis* species), in which pollen and honey are stored and the brood is reared.

honeyeaters *See* Meliphagidae; and *Myzomela*.

honey fungus *See Armillaria mellea*.

honeyguides *See Indicator*; Indicatoridae; and Piciformes.

honeysuckles (*Lonicera*) *See* Caprifoliaceae.

hoof-and-mouth disease *See* foot-and-mouth disease.

Hookeriales (subclass Bryidae) Order of pleurocarpous mosses, which are found mainly in tropical regions. There are several genera, including *Hookeria*. The only British species of *Hookeria* is *H. lucens*: a characteristic plant with large, translucent, bright green leaves, and flattened shoots. The leaf cells are very large and thin-walled: they are almost visible to the naked eye and easily visible under a hand lens. There is no nerve. It is found in deep shade in moist habitats, mainly in northern and western regions.

hookworm disease Disease of certain Mammalia, including humans, caused by infestation of the intestine by parasitic nematodes, the most important species being *Ancylostoma duodenale*, *A. braziliense*, *A. ceylanicum*, *A. caninum* and *Necator americanus*. Each nematode is 8–16 mm long and causes blood loss at its site of attachment.

Symptoms include anaemia, diarrhoea, general debilitation, physical and mental retardation, and death. The severity of the disease depends on the extent of the infestation. The parasite is transmitted in faeces containing eggs, which develop into larvae capable of penetrating the skin of their hosts. The disease is common in low latitudes.

hoopoe (*Upupa epops*) *See* Upupidae; and Coraciiformes.

hop *See Humulus*; and Cannabidaceae.

hop bush *See Dononaea*.

Hopea (family Diptocarpaceae) Genus of resinous trees, many of which have heavy timber. There are 90 species, occurring from S. China to New Guinea.

Hoplichthyidae (ghost flathead; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish, resembling the true flatheads (Platycephalidae) in that the head and anterior part of the body are very depressed and wide, the second dorsal and anal fins are very long, and the lower three of the pectoral-fin rays are free. There are several species, found in the Indo-Pacific region.

Hoplitis *See* mason bee.

Hoplocarida *See* Stomatopoda.

Hoplonemertini (phylum Nemertini, subclass Anopla) Order of nemertinid worms which possess a relatively complex proboscis. All have a straight intestine.

Hoplopleuridae (order Phthiraptera, suborder Anoplura) Family of sucking lice which are parasitic on the mammalian orders Rodentia, Insectivora, and Lagomorpha. Members of the family differ from other Anoplura in having lateral extensions of the second abdominal sternal plate which articulate with the second paratergal plates. The lice are very slender and hold on to single hairs of their host, so that their detection and removal by the host is difficult. There are five genera, with 132 species.

horizon In pedology, a relatively uniform soil layer that lies, at any depth in the soil profile, parallel, or nearly so, with the soil surface, and which is differentiated from adjacent horizons above and below by contrasts in mineral or organic properties.

hormogonium Short length of a filament or trichome in certain filamentous cyanobacteria that becomes detached and functions as a propagule.

hormone Regulatory substance, active at low concentrations, that is produced in specialized cells but that exerts its effect either on distant cells or on all cells in the organism to which it is conveyed via tissue fluids.

horn (geomorph.) Pyramidal or triangular-faced peak in a mountainous region, produced by the intersection of three or more cirques. The Matterhorn (Switzerland) is the type example. Typically, arêtes radiate from a well-developed horn.

hornbeam *See Carpinus*; and Betulaceae.

hornbills *See* Bucerotidae; Coraciiformes; and *Tockus*.

hornblende Mineral, with the chemical composition $Ca_2Na(MgFe)_4(AlFe)([SiAl_4]O_{11})_2OH_2$. It occurs as a common constituent of medium basic, igneous rocks (e.g. syenites, diorites, and granodiorites), also in contact metasomatic zones, and extensively in metamorphic rocks (e.g. schists, gneisses, and amphibolites). It is distinguished by its colour and by two cleavages set at 124°. It is usually a shade of green or brown; it has a white streak with a greenish tint, and a vitreous lustre. It crystallizes in the monoclinic system. The crystals are normally prismatic, columnar, and occasionally isometric. It is an important rock-forming mineral.

Hornea *See Tmesipteris*.

horned coot (*Fulica cornuta*) *See Fulica*.

horned lark (*Eremophila alpestris*) *See* Alaudidae.

horned lizards *See Phrynosoma*.

horned viper *See Vipera ammodytes*.

hornet *See Vespa crabro*.

hornfels Fine-grained rock which lacks a schistosity. It is produced by contact or thermal metamorphism.

horn of plenty Common name for the edible fruit bodies of the fungus *Craterellus cornucopioides*. The cap is funnel-shaped with a wavy edge; the inside of the funnel is black to brownish-black, while the outer surface is dark grey. The spore print is white. It is found in groups on the ground under trees (especially beech) in late summer and autumn.

horntails *See* Siricidae; and *Uroceras gigas*.

hornwort Common name for a liverwort of the unique class Anthocerotales; sometimes regarded not as a liverwort but as a distinct type of plant.

horotely (adj. horotelic) Normal or average rate of evolution per million years, of genera within a given taxonomic group. Thus slowly or rapidly evolving lines may be horotelic during certain episodes in their history.

horse (*Equus*) *See* Equidae.

horse chestnut (*Aesculus hippocastanum*) *See Aesculus*; and Hippocastanaceae.

horseflies *See* Tabanidae.

horse latitudes Subtropical latitudes coinciding with a major anticyclonic belt; they are characterized by generally settled weather and light or moderate winds.

horse mushroom Common name for the fruit body of *Agaricus arvensis*, which resembles the cultivated mushroom but is larger and smells of aniseed or almonds. It is edible and highly esteemed. It is found in pastures, on road verges, etc. during summer and autumn.

horseradish tree (*Moringa oleifera*) *See Moringa*.

horseshoe bat *See* Rhinolophidae.

horseshoe crab *See* Merostomata.

horse-stingers *See* Odonata.

horsetails *See Equisetum*.

Horsfieldia (family Myristicaceae) Genus of trees with monopodial crowns, whose fruit is a leathery capsule with one big seed with an entire aril. There are 80 species, occurring from S. China to Queensland.

horst Upthrown area lying between two steep-angled fault blocks. *Compare* graben; *see also* rift zone.

Horton analysis Calculation of a range of dimensionless drainage-network relationships (*see* bifurcation ratio for example), based on a system of stream ordering, i.e. the numerical ranking of channel segments within a channel network. Proposed by R. E. Horton in 1945.

horus swift (*Apus horus*) *See Apus*.

host *See* graft; and parasitism.

Hottentot fig (*Carpo brotus*) *See* Aizoaceae.

houndfish (*Tylosurus crocodilus*) *See* Belonidae.

house-bote Building timber (from 'bote', meaning 'bounty' or 'gift').

house bunting (*Emberiza striolata*) *See Emberiza*.

house cricket *See* Gryllidae.

houseflies *See* Muscidae.

house leeks (*Sempervivum*) *See* Crassulaceae.

house longhorn beetle (*Hylotrupes bajulus*) *See* Cerambycidae.

house martin (*Delichon urbica*) *See Delichon*.

house mouse (*Mus musculus*) *See* Muridae.

house sparrow (*Passer domesticus*) *See Passer*.

house spider *See Tegenaria gigantea*.

hoverflies *See* Syrphidae.

Howea (sentry palm; family Palmae) Genus of palms which have a single, closely hoop-marked trunk. The leaves are pinnate. The trees are monoecious, with inflorescences among the leaves. They are very commonly cultivated. There are two species, both endemic to Lord Howe Island (Australia).

howler monkey (*Alouatta*) *See* Cebidae.

Hoya (family Asclepiadaceae) Genus of twining and root-climbing plants, with fleshy leaves, and flowers which are waxy, highly fragrant, showy, and borne in umbels. They are delightful hothouse ornamentals. There are 200 species, native from S. China to the Pacific.

hue *See* Munsell colour.

huia (*Heteralocha acutirostris*) *See* Callaeidae.

human being *See Homo*; and *Homo sapiens sapiens*.

human body louse (*Pediculus humanus*) *See* Pediculidae.

human ecology The application of ecological principles to the study of humans and human society.

human head louse (*Pediculus capitis*) *See* Pediculidae.

human warble fly (*Dermatobia hominis*) *See* Oestridae.

Humboldt current *See* Peru current.

humerus In tetrapods, the upper bone of the forelimb.

humic acid Mixture of dark-brown organic substances, which can be extracted from soil with dilute alkali and precipitated by acidification to pH 1–2 (in contrast with fulvic acid, which remains soluble in acid solution).

humidity Expression of the moisture content of the atmosphere. Measures of humidity include statements of the total mass of water in 1 m^3 of air (absolute humidity), the mass of water vapour in a given mass of air (specific humidity), relative humidity, vapour pressure, and the mixing ratio.

humification Development of humus from dead organic material, by the action of saprotrophic organisms which use this dead material as their food source. Humification is essentially an oxidation process in which complex organic molecules are broken down into simpler organic acids which may subsequently be mineralized into simple, inorganic forms suitable for uptake by plants. Humification is therefore a vital stage in the cycling of nutrients.

humilis From the Latin *humilis* meaning 'low', a species of cumulus cloud which is shallow and which typically has a flattened appearance. *See also* cloud classification.

hummingbirds 1 *See Amazilia; Anthracothorax*; Apodiformes; *Archilochus*; and Trochilidae. 2 (hermits) *See Phaethornis*.

hump-backed dolphin (*Sousa*) *See* Stenidae.

humpback whale (*Megaptera novaengliae*) *See* Balaenopteridae.

hump-winged cricket *See* Prophalanopsidae.

Humulus (family Cannabidaceae) Genus of perennial climbing herbs, whose fruit is an achene enclosed by persistent perianth. *H. lupulus* is the hop. There are four species, occurring mainly in the northern temperate zone.

humus 1 Decomposed organic matter of soils that are aerobic for part of the year: it is dark brown and amorphous, having lost all trace of the structure and composition of the vegetable and animal matter from which it was derived. 2 Surface organic soil horizon that may be divided into types, e.g. mor (acid and layered) or mull (alkaline and decomposed). It is the 'histic epipedon' of the USDA Soil Taxonomy. *See also* humification.

hunting dog (*Lycaon pictus*) *See* Canidae.

hunting spiders *See* Lycosidae.

hunting wasp Any member of the following families of aculeate wasps in which the females seek spider or insect prey which they sting and paralyse, and then transport to the nest as food for their larvae: Pompilidae (spider-hunting wasps), Vespidae subfamily Eumeninae (caterpillar and beetle-hunting wasps), and Ampulicidae and Sphecidae (digger wasps). In primitive pompilids and ampulicids, prey is caught before a nest is prepared, and the nest is often no more than a shallow scrape in

the soil, or a pre-existing cavity. In more advanced forms, a nest is excavated or built before the prey is caught.

huntsman spider (*Heteropoda venatoria*) *See* Sparassidae.

hurricane Intense tropical cyclone of the Caribbean region and on the north-east coast of Australia (Queensland). Similar types of storm in other parts of the world are known as 'typhoon' (W. Pacific), and 'cyclone' (Bay of Bengal). The storm has a maximum wind speed exceeding 117 km/h. The term 'hurricane' is also applied on the Beaufort scale to a force of magnitude 12 (mean speed 64 knots or more).

hutia *See* Capromyidae.

Hyaena *See* Hyaenidae.

Hyaenidae (hyenas; order Carnivora, suborder Fissipedia, superfamily Feloidea) Family of carnivores whose ancestors evolved rapidly from the Viverridae (civets) in late Miocene times. They are the youngest feloids (civets, cats, and hyenas). They displaced the last hyaenodont from the scavenging niche, and although today they are restricted to the Old World, one form entered N. America in the early Pleistocene. Hyenas possess heavy, blunt teeth and strong jaws, allowing them to crush bones and so to live partly by scavenging. The aardwolf (*Proteles cristatus*) resembles a small hyena superficially, and is also descended from the viverrid group, but it feeds mainly on insects and has weaker jaws and fewer teeth. Hyaenids have hind limbs that are shorter than the forelimbs; non-retractile claws; a digitigrade gait; and long skulls. They are distributed widely in Africa and S. Asia as far east as India. Apart from *Proteles* there are two genera, with three species: the striped and brown hyenas (*Hyaena*) and the spotted hyena (*Crocuta*).

Hyaenodontidae (superorder Ferae, order Creodonta) Extinct family of carnivorous mammals which appeared early in the Eocene and flourished throughout most of the Tertiary. They were slimly built, with elongated jaws; probably they possessed claws, and many had well developed carnassials, differing from those of modern carnivores in being formed from the first or second molars of upper and lower jaws (rather than from the upper premolar and lower molar). Some forms (e.g. *Machaeroides* and *Apataelurus*) had jaws similar to those of the later sabre-toothed cats. Hyaenodonts ranged in size from animals the size of a weasel to some large enough to have preyed on large herbivores.

hyaline Translucent or transparent; glass-like.

hyaloplasm Ground substance of cell cytoplasm, within which the various subcellular organelles and membranaceous components are embedded.

Hyalosponges *See* Hexactinellida.

hyaluronic acid Highly viscous acid mucopolysaccharide, composed of D-glucuronic acid and *N*-acetyl-D-glucosamine. It is widely distributed throughout the connective tissues of animals. It is thought to have various functions, including maintaining the level of hydration in tissues, acting as a molecular sieve in restricting the movement of large molecules in tissues, and preventing the spread of pathogens and toxic substances.

Hybanthus (family Violaceae) Genus of perennial, often creeping herbs and shrubs, whose leaves are alternate or in clusters; occasionally opposite, sessile, or with a short petiole; and entire or slightly toothed, with or without stipules. The flowers are held in axillary racemes or cymes, or are solitary. They are irregular and bisexual. The sepals are of similar length; the petals irregular, with a broad, spurred, and clawed lower lobe. The stamens are often attached to the corolla. The fruit is a dehiscent capsule. There are about 150 species, found in tropical and subtropical regions of the world, often in mountainous areas. The roots of *H. ipecacuanha* yield the drug urogoga and are used as an emetic.

Hybocrinida (subclass Inadunata) Small order of monocyclic crinoids (i.e. there is only one circlet of plates beneath the radial plates that bear the arms). They show a tendency toward reduction or loss of the arms, and their replacement by recumbent ambulacral grooves. They are known only from the Ordovician.

hybrid 1 Individual plant or animal resulting from a cross between parents of differing genotypes. Strictly, most individuals in an outbreeding population are hybrids, but the term is more usually reserved for cases in which the parents are individuals whose genomes are sufficiently distinct for them to be recognized as different species or subspecies. A good example is the mule, produced by cross-breeding an ass and a horse (each of which can breed true as a species). Hybrids may be fertile or sterile depending on qualitative and/or quantitative differences in the genomes of the two parents. Hybrids like the mule, whose parents are of different species, are frequently sterile. **2** By analogy with (1), any heterozygote. Each heterozygote represents dissimilar alleles at a given locus, and this difference results from a cross between parental gametes possessing differing alleles at that locus. **3** (graft hybrid) *See* graft.

hybrid swarm Continuous series of hybrids that are morphologically distinct from one another, resulting from the hybridization of two species followed by the crossing and backcrossing of subsequent generations. The hybrids are very variable owing to segregation of alleles at each locus.

hybrid vigour *See* heterosis.

hybrid zone Geographical zone in which the hybrids of two geographical races may be found.

hydatid disease Disease in humans caused by infestation by the tapeworms *Echinococcus granulosus* and *E. multilocularis*, parasites whose larval stage requires a human host and whose adult form requires a dog as host. Human infestation arises from the ingestion of eggs acquired by contact with the faeces of infested dogs, and is most common in children. The adult worm is small; but the larva, known as a hydatid cyst, is often large, sometimes

reaching the size of a grapefruit after five years in a human body. The cysts attach at various sites and cause illness by pressure on organs, by the release of toxic metabolites and by shock should they rupture to cause a sudden massive invasion of host tissue. If they develop inside bones the bone structure is weakened, leading eventually to fracture.

Hydnaceae (order Aphyllophorales) Family of fungi, in which the fruit bodies bear the hymenium on tooth-like spines. They are found on wood, soil, etc. They are mostly rare, often producing fruit bodies only at intervals of several years. Many genera formerly included in this family are now considered to belong to other families, e.g. the Auriscalpiaceae.

Hydnocarpus (family Flacourtiaceae) Genus of trees, in which the flowers are unisexual, and small. The fruits are large, globose, woody, indehiscent, and contain many seeds set in pulp. The seeds contain fatty acids, from which chaulmoogra oil (from *H. anthelmintica* and *H. kurzii*) is obtained. It is used to treat skin diseases and formerly to treat leprosy. There are 40 species, found in rain forests from India to the Philippines and Celebes.

Hydnophytum (family Rubiaceae) Genus of epiphytic herbs, which have a swollen stem base with ant-inhabited chambers. There are 80 species, occurring from the Andamans to the Pacific islands.

Hydnum (family Hydnaceae) Genus of fungi, in which the fruit bodies are fleshy and stipitate and the hymenium is borne on spines which hang down from the under-side of the cap. The spore print is brown. Species grow exclusively on the ground, typically in woodland.

Hydra *See* Hydroida.

Hydraenidae (class Insecta, order Coleoptera) Family of tiny beetles, about 1.5 mm long, found in stagnant water. The ventral surface is flat, the upper surface very convex. The elytra are generally black to metallic. The maxillary palps are long, the antennae short, with five-segmented clubs. The ocelli are well developed, possibly indicating an affinity with Staphylinidae. Some larvae are aquatic, others live only partly in water. Adults and larvae are phytophagous, often feeding on dead material. There are 300 species.

hydrarch succession *See* hydrosere.

hydraulic radius Ratio between the cross-sectional area of a stream channel and the length of the water-channel contact at that cross-section (the wetted perimeter). It is a measure of channel efficiency: the higher the ratio, the more efficient is the channel in transmitting water.

hydric *See* mesic.

Hydrobatidae (storm petrels; order Procellariiformes) Family of small, brown-black or grey seabirds, which have white rumps or under-parts. The bill and legs are usually black. Storm petrels have long wings, and medium to short, square or forked tails. They are pelagic and gregarious, feed on surface plankton, and breed in burrows and crevices on islands. There are 2–8 genera, with 20–22 species, found in all oceans.

hydrocarbon Naturally occurring organic compound containing carbon and hydrogen. Hydrocarbons may be gaseous, solid, or liquid, and include natural gas, bitumens, and petroleum.

Hydrocharis (frog-bit) *See* Hydrocharitaceae.

Hydrocharitaceae Family of aquatic, monocotyledonous herbs with regular, usually dioecious flowers within spathes, usually with three sepals and three petals, 1–3 or more stamens, and an inferior one-celled ovary. The family includes *Hydrocharis* (frog-bit) and *Elodea*. In modern classifications there are 16 genera, with 70 species. They are mostly tropical but also found in the temperate zone.

Hydrochidae (class Insecta, order Coleoptera) Family of small, black or bronze beetles about 3 mm long, which are generally found on water plants. The maxillary palps are long. The antennae have three-segmented clubs. Formerly the family was included in the Hydraenidae, but there are essential structural differences. Little is known of the larvae. There are 69 species.

Hydrochoeridae (capybara; order Rodentia, suborder Hystricomorpha) Family comprising one genus, with a single species, *Hydrochoerus hydrochaeris*, the largest of all rodents, which grows to a weight of 50 kg or more. Capybaras are semi-aquatic, with digits partially webbed, and eyes and ears small and positioned high on the skull. The body is sparsely covered with hair, and the tail is vestigial. Capybaras are distributed throughout tropical S. America east of the Andes.

Hydrochoerus hydrochaeris (capybara) *See* Hydrochoeridae.

Hydrocorallina (class Hydrozoa) Term that includes the cnidarian orders Milleporina and Stylasterina.

hydrocorals *See* Hydrocorallina.

hydrofuge hair Water-repellant, cuticular hair on the body of an insect, which serves a variety of functions. Mosquito larvae use hydrofuge hairs to seal their respiratory siphons when they dive; some Coleoptera use them to create a physical gill (the plastron).

hydrogenase Enzyme that catalyses reactions involving the hydrolysis of a substrate by molecular hydrogen.

hydrogen bond Force of attraction between polar molecules containing hydrogen atoms or between one part of a molecular chain and another part containing bonded hydrogen. In water, for example, the slightly positively-charged hydrogen nucleus is attracted to the slightly negatively-charged oxygen nucleus of another water molecule to form a hydrogen bond.

hydrogeology Branch of geology concerned with the Earth's water, including its physics, chemistry, and environmental relationships.

hydroid *See* Hydroida; and Hydrozoa.

Hydroida (hydroids; class Hydrozoa) Order of Cnidaria with a well-developed polypoid generation. They are fixed, solitary or colonial, and many have a chitinous exoskeleton, although some (e.g. *Hydra*) are naked. There are free medusae or aborted structures on the polypoids. The medusae have ocelli or ectodermal statocysts, or both.

hydrolase Enzyme that catalyses reactions involving the hydrolysis of a substrate.

hydrological cycle Representation of the flow of water in various states through the terrestrial and atmospheric environments. Storage points (stages) involve ground water and surface water, icecaps, oceans, and the atmosphere. Exchanges between stages involve evaporation and transpiration from the Earth's surface, condensation to form clouds, and precipitation followed by run-off. *See also* residence time.

hydrolysis 1 (biochem.) Reaction between a substance and water in which the substance is split into two or more products. At the points of cleavage the products react with the hydrogen or hydroxyl ions derived from water. 2 (pedol.) Process of enriching the soil adsorption complex with hydrogen after exchangeable metallic ions have been replaced by hydrogen ions. *Compare* weathering.

Hydromyxomycetes (division Myxomycota) Class of eukaryotic organisms which form a net-like feeding stage called a net plasmodium. Sometimes they are classified in the Protozoa. The class contains the order Labyrinthulales.

hydronasty Nastic movement induced in plant organs by changes in atmospheric humidity.

Hydrophiidae (sea snakes; order Squamata, suborder Serpentes (Ophidia)) Family of marine descendants of the Elapidae, comprising venomous, front-fanged snakes. They have valvular nostrils and salt-secreting glands in the head, long bodies (generally with small ventral scales), and laterally compressed tails. Most are ovoviviparous. They prey mainly on small fish. There are about 50 species, occurring in the Indian and Pacific Oceans.

hydrophilic Applied to a molecule or surface that can become wetted or solvated by water. This ability is characteristic of polar compounds.

Hydrophilidae (water beetles; class Insecta, order Coleoptera) Family of beetles, 1–40 mm long, most of which have a 'Y'-shaped impressed line on the vertex (the top, behind the eyes and between them) of the head. The maxillary palps are usually longer than the antennae, which, in aquatic forms, have a respiratory function. The aquatic species are dark, convex and shiny. Females carry eggs beneath the abdomen in a silk cocoon. Adults are usually phytophagous; larvae are carnivorous. *Hydrophilus piceus* (great silver diving beetle) is Britain's heaviest beetle. Its silvery appearance in water is due to the layer of air carried beneath the elytra and on the ventral surface. Its larvae feed on snails. Land-living species are associated with damp places and dung, and are often paler than aquatics, with more heavily sculptured elytra. There are 2000 species, and their distribution is more abundant in the tropics.

Hydrophilus piceus (great silver diving beetle) *See* Hydrophilidae.

hydrophobia *See* rabies.

hydrophobic Applied to a molecule or surface that can resist wetting or solvation by water. The ability is characteristic of non-polar compounds.

Hydrophyllaceae Family of annual or perennial herbs and small shrubs, which have alternate, hairy or glandular, simple or compound leaves, without stipules. The flowers are regular, bisexual, usually blue or purple, and borne in cymes. They have five free sepals, often with auricles between the calyx lobes. The corolla is fused at the base into a bell- or funnel-shape, with five stamens inserted into the base. The ovary is superior with two fused carpels and one or two locules, each with two or more ovules. There are one or two styles. The fruit is an elongated capsule which splits along its length: it contains numerous seeds with fleshy endosperm. There are about 18 genera, with 250 species, found throughout the world. Several species are ornamentals.

hydrophyte Plant that is adapted morphologically and/or physiologically to grow in water or very wet environments. Adaptations include the development of finely-divided submerged leaves, large floating leaves, the presence of aerenchyma, and the reduction of root systems. The perennating bud lies at the bottom of fairly open water. With the leaves submerged or floating, only the inflorescence protrudes above the water surface (e.g. *Nuphar lutea*, yellow water-lily). *Compare* helophyte.

hydroponics Plant growth in a liquid culture solution rather than in soil. This approach is used commonly in experimental studies of mineral nutrient deficiencies or excesses, and their effects. Hydroponics also has commercial applications, though to date it has not been used extensively in this way.

hydrosere (hydrarch succession) Sequence of communities reflecting the developmental stages in a plant succession in open fresh water. *See also* succession.

hydrospire *See* Blastoidea.

hydrostatic organ (of fish) *See* swim bladder.

hydrotaxis Movement of an organism in response to the stimulus of water.

hydrothermal activity Activity, often associated with late-stage igneous action, which involves heated or superheated water and possibly mineralization. Hydrothermal fluids may be only partly of magmatic origin, since mixing with meteoric ground waters may also occur.

hydrothermal mineral Mineral formed as a result of hydrothermal activity. For example, the kaolinite (china clay) deposits of Cornwall were formed by the hydrothermal alteration of feldspars in granitic rocks.

hydrotropism Directional growth of a plant organ towards wetter regions in response to the stimulus of water.

hydrous mica (illite) *See* clay minerals.

Hydrozoa (hydroids; phylum Cnidaria) Class of multicellular, mainly marine animals with cells arranged in two layers, epidermis and gastrodermis (endodermis), separated by a gelatinous mesogloea. These enclose a continuous digestive cavity (coelenteron), which communicates directly with the exterior by a single aperture (mouth) and is lined by a gastrodermis. The gastrodermis lacks nematocysts. Eggs and sperm are shed outside the animal and not into the gastrovascular cavity.

hyena *See* Hyaenidae.

Hygrobiidae (screech beetles; class Insecta, order Coleoptera) Family of highly convex water beetles, found in muddy ponds. They possess several primitive features—including, in the adult, swimming by means of alternate leg movements—and very prominent eyes. Adults produce high-pitched squeaks by rubbing the tip of the abdomen against the under-side of the elytra. Larvae are club-shaped, with a large head and thorax and a three-pronged tail, and feed on insect larvae. There are four species, with notably discontinuous distribution, occurring in Australia, Asia, and Europe.

Hygrocybe (family Hygrophoraceae) Genus of fungi in which the mushroom-like fruit bodies are small, often brightly coloured, and have slimy or greasy caps and waxy gills. There are numerous species, found in grassland.

hygrometer Instrument for measuring atmospheric humidity. Types include the wet-bulb–dry-bulb, dew-point, and hair hygrometers, and there is one type based on electrical resistance. *See also* psychrometer.

hygrophanous Translucent and watery in appearance.

hygrophilic *See* hygrophilous.

hygrophilous (hygrophilic) Growing in or preferring moist habitats.

Hygrophoraceae (order Agaricales) Family of fungi, which form waxy, often brightly coloured fruit bodies bearing thick but sharp-edged gills. There are five genera, found on the ground in woods or grassland.

Hygrophoropsis (family Tricholomataceae) Genus of fungi, which form mushroom-like fruit bodies. *H. aurantiaca* forms bright-orange fruit bodies which are sometimes mistaken for chanterelles, hence the common name 'false chanterelle'. *Hygrophoropsis* are found on the ground in conifer woods and heathland.

Hygrophorus (family Hygrophoraceae) Genus of fungi, in which the mushroom-like fruit bodies have slimy or greasy caps, and waxy gills. There are many species. They are found in woodland, where they form mycorrhizal associations with trees.

hygroscopic nucleus Microscopic particle (e.g. of sulphur dioxide, salt, dust, or smoke), in the free air, on which water vapour may condense to form droplets. Aerosols that are soluble in water (e.g. salt or sulphuric acid) can induce condensation in unsaturated air—for example, salt nuclei can induce it at a relative humidity of less than 80%. The size of nuclei may be from 0.001 μm to more than 10 μm (i.e. 'giant' nuclei such as particles of sea salt). *See also* Aitken nuclei; and nucleus

hygroscopic water Water absorbed from the atmosphere and held very tightly by the soil particles, so that it is unavailable to plants in amounts sufficient for them to survive. *Compare* capillary moisture.

hygrotaxis Movement of an organism in response to the stimulus of humidity or moisture.

hygrothermograph (thermo-hygrograph) Instrument for the continuous recording of both the temperature and humidity of the air, on separate traces.

Hyla arborea (European tree frog, green tree frog; order Anura (Salientia), family Hylidae) Tree frog which grows up to 5 cm long, and has digits with adhesive discs, but no nuptial-pad development. It is capable of changing colour from light green to brown. The male has a balloon-like vocal sac. *H. arborea* is the only tree frog in Europe, its range extending into N. Africa and temperate Asia.

Hylaeinae *See* Colletidae.

Hylaeus *See* Colletidae.

Hylidae (tree frogs; class Amphibia, order Anura (Salientia), suborder Procoela) Family of frogs whose feet have suction pads. The digits are elongated with an extra, cartilaginous element. Brood-care behaviour is often well developed. There are 600 species, widespread in tropical and temperate zones. They are mainly arboreal, but a few are secondarily ground-living, or aquatic.

Hylobates (gibbons) *See* Hylobatidae.

Hylobatidae (lesser apes; order Primates, suborder Haplorhini, superfamily Hominoidea) Family of apes, which includes gibbons and their relatives. They are small in size, and specialized for brachiation with long legs, extremely long arms, and a hook-like hand. The canines are long and sharp in both sexes. Generally they are placed in one genus (*Hylobates*) with three subgenera: *Hylobates* (true gibbons), *Symphalangus* (siamangs), and *Nomascus* (concolors). They are distributed throughout SE Asia, from Assam to Java. There are about nine species.

Hylonomus lyelli Ancient, probably the oldest-known, reptile. *Hylonomus* is a stem reptile and is a member of the Captorhinomorphidae. It was first found in fossilized tree stumps in the Coal Measures of Nova Scotia. The skull roof of this species was fully ossified and there were no openings behind the eye sockets. *Hylonomus* measured some 5 cm and possessed a long tail.

Hylotrupes bajulus (house longhorn beetle) *See* Cerambycidae.

hymenium Layer of spore-bearing structures (asci or basidia) on or within a fungal fruit body.

Hymenomycetes (subdivision Basidiomycotina) Large class of fungi in which the basidia are

typically organized into a hymenium that is exposed at maturity. Basidiospores are discharged forcibly when mature. There are two subclasses, nine orders, and numerous genera. The class includes most of the fungi familiar as mushrooms, toadstools, bracket fungi, jelly fungi, etc.

Hymenophyllaceae Family of filmy ferns with gradate sori on the frond margins, and thin, membranaceous fronds with the lamina only one cell thick. At present 39 genera and some 630 species are accepted. They are found mostly in the moist tropics, but with a few genera extending into mild oceanic temperate areas, where they occur mainly in very humid shady habitats.

Hymenophyllum (family Hymenophyllaceae) Genus of filmy ferns with two-lipped indusia to the marginal sori, widespread in the moist tropics but also occurring in humid temperate areas, including Europe.

Hymenoptera (ants, bees, sawflies, wasps; class Insecta, subclass Pterygota) Very large, complex, and diverse order, whose members show a high degree of adaptive radiation. There are two suborders, the Symphyta (sawflies), which do not have a constricted waist, and the Apocrita, (ants, bees, and wasps), of which there are about 105 000 species worldwide, in which the waist is constricted. Hymenoptera have two pairs of wings, the forewings a little longer than the hindwings, and both pairs with relatively few veins. In flight, the wings can be linked together by means of hamuli (hook-like processes on the anterior margin of the hindwing which interlock with the forewing). Adults can be found in a large variety of habitats. They have mouthparts that are either adapted for chewing or with the maxillae and labium modified to form a proboscis for sucking nectar, etc. The antennae are usually fairly long, with 10 or more segments. The ovipositor may be modified for sawing, piercing, or stinging (for defence or the paralysis of prey and hosts). Members of the order have complete metamorphosis, the pupae being adecticous (having mandibles which are non-articulated and often reduced, and which generally are not used for escape from the cocoon), and usually exarate (the legs and appendages are free and visible, the abdomen is capable of movement, and the pupa may be able to achieve some limited degree of locomotion). Pupation normally takes place in a cocoon, in a special cell, or in the body of the host (in the case of parasitic species). The larvae of many species are plant feeders; many others are parasitic, living in or upon the bodies of other insects; still others live in special nests, constructed by the adults, and feed on materials with which the nest is provisioned. Some Hymenoptera are social insects whose life histories and biology are well known. Many Hymenoptera are extremely useful in the biological control of pest species. Some are important pollinators. Others are pests of cultivated plants, in some cases causing serious defoliation. The taxonomic characters used in the classification of the order include wing venation, the legs, the antennae, the pronotum, the thoracic structures, and the ovipositor.

Hymenostomatida (class Ciliatea) Order of ciliate protozoa in which the mouth region is subterminal and located on the ventral surface of the cell. The arrangement of cilia in the mouth region is complex. Beating of these cilia causes water currents to direct food toward the mouth. There are three suborders. Most species are free-living in freshwater habitats, a few are parasitic.

hynobiid Applied to the most primitive of living salamanders, the Hynobiidae, and to amphibians that resemble them.

Hynobiidae (hynobiids, Asian land salamanders; class Amphibia, Order Urodela (Caudata)) Family of amphibians in which metamorphosis is complete, adults lacking larval teeth or gills. They grow to about 8–25 cm long. Some species are found in mountain streams at altitudes up to 400 m. The lungs are sometimes lost, presumably to reduce buoyancy in fast-flowing water. There are five genera, with about 30 species, all of which are Asiatic.

hyoid A bone or bones developed from the second visceral arch which support the tongue.

Hyolithida (phylum Mollusca, class Calyptoptomatida) Order of pyramid-shaped calyptoptomatids which have conical embryonic chambers. The operculum possesses one or two pairs of muscle scars which are bilaterally symmetrical. The shell is externally undifferentiated, and internally it is non-septate. The order ranges in age from Lower Cambrian to Middle Permian.

Hyopsodontidae (superorder Protoungulata, order Condylarthra) Extinct family of Palaeocene and Eocene mammals, mainly N. American but with at least one S. American genus, whose members possessed bunodont, quadritubercular cheek teeth, relating them to the ungulates, but had clawed digits. *Hyopsodus* was about 30 cm long, and possibly semi-arboreal. *Mioclaenus*, an earlier genus, had sharp-cusped, creodont-like teeth.

hypanthium Cup-like or tube-like enlargement of the floral receptacle or base of the perianth that surrounds the gynoecium and fruits.

Hypericaceae Former plant family: its members are now included in the family Guttiferae.

Hypermastigida (class Zoomastigophorea) Order of protozoa, which have many flagella. They inhabit the alimentary tracts of cockroaches, woodroaches, and termites, with which they appear to have a mutualistic relationship.

hypermorphosis Acceleration of development so that the organism reaches its adult size and form well before the attainment of sexual maturity, and continues to develop into a 'super-adult'.

Hyperoartii Older name for the order Petromyzoniformes (lampreys).

Hyperoglyphe porosa (deep-sea trevalla) *See* Centrolophidae.

Hyperoodon (bottle-nosed whale) *See* Ziphiidae.

Hyperotreti Older name for the order Myxiniformes (hagfish).

hyperparasite Parasitic insect that lives in or on a host that is itself parasitic on another species of insect. If the parasite kills the host as a consequence of its own development it is more commonly called a 'parasitoid'. *See also* Pteromalidae.

hypersthene Mineral, specific gravity 3.5, hardness 5.0–6.0, and with the chemical composition $(MgFe)_2(Si_2O_6)$, whose name is derived from Greek and means 'very strong'. It occurs in iron-rich, basic, igneous rocks, e.g. gabbro-norites, trachytes, and andesites. It is green to greenish, or brownish-black, and it has a vitreous lustre. It crystallizes in the orthorhombic system. The crystals can be prismatic or tabular, but they are usually irregular grains. It is a rock-forming mineral.

hyperthermic *See* pergelic.

Hypertragulidae Family of primitive ruminant artiodactyls belonging to the superfamily Traguloidea, though often included in the Pecora in the broadest sense. A few representatives are known from the late Eocene and Oligocene of Eurasia, but the family as a whole flourished in the Oligocene and early Miocene of N. America.

hypha Thread-like filament that is the structural unit in many fungi and actinomycetes.

Hyphaene (family Palmae) Genus of fan palms whose trunks branch by a true dichotomy. They are dioecious. The inflorescences are stout and much-branched, and are borne among the leaves. The fruits have a juicy pulp, the stigma is basal, and there is one seed with a stony wall. In Egypt *H. thebaica* (doum or gingerbread palm) has been cultivated since time immemorial for its gingerbread-flavoured fruits. There are 40 species, most of them African.

Hyphochytridiomycetes (subdivision Mastigomycotina) Class of microscopic fungi found mainly in aquatic habitats as parasites in algae and aquatic fungi, and as saprotrophs on dead plant and animal remains.

Hypholoma (family Strophariaceae) Genus of fungi in which the fruit bodies are mushroom-shaped, and are typically some shade of yellow or brown. The spores are dark brown or purplish-brown. *Hypholoma* are found on peaty ground among mosses, or on wood, especially on tree-stumps. *See also* sulphur tuft.

Hyphomicrobium Genus of bacteria which are not assigned to any taxonomic family. The cells are variable in shape (spindle-shaped, egg-shaped, bean-shaped, etc.), and develop thread-like extensions which may branch. From the tips of these extensions, motile (flagellated) cells are produced by budding; these subsequently attach to a substrate, lose motility, and develop thread-like extensions, thus completing the cycle. These bacteria are aerobic chemo-organotrophs, found chiefly in soil.

Hyphomycetes (subdivision Deuteromycotina) Class of imperfect fungi in which the vegetative stage is a well-developed mycelium. In some species sexual states are unknown; others are the conidial states of fungi classified in other subdivisions. There are many species. Sometimes the class is considered to contain a single order, sometimes it is not subdivided into orders and families. It includes predatory, parasitic, and saprotrophic fungi, found in aquatic or terrestrial habitats.

Hypnobryales (subclass Bryidae) Order of pleurocarpous, slender to robust mosses. The leaves are lanceolate to rounded, and may be nerveless or have a single or double nerve. The capsule is ovoid or cylindrical and inclined or horizontal; the peristome is double. There are many genera, including *Brachythecium*, *Eurhynchium*, *Homalothecium*, *Hylocomium*, *Hypnum*, *Rhynchostegium*, and *Rhytidiadelphus*. They are found in a wide range of habitats.

Hypnum (order Hypnobryales) Genus of mosses in which the stems are creeping to erect, and almost unbranched to closely pinnately branched; branch leaves are similar in shape to the stem leaves, but are smaller. The capsule is erect to horizontal, and ovoid to cylindrical; and is borne on a long, reddish seta. *Hypnum* is a cosmopolitan genus, with about 220 species. *H. cupressiforme* is one of the commonest British mosses. It is very variable in form, with a number of distinct varieties. The typical form is a prostrate moss with pinnate branching; the leaves are concave, curved, and overlap one another to give some resemblance to a cypress branchlet. The leaves are nerveless and the leaf cells are long and narrow. The capsule is cylindrical and curved and has a beaked lid. The leaves are characteristically all turned downwards, especially at branch tips, although this character is lacking in some of the varieties. *H. cupressiforme* is found in a very wide range of habitats.

hypobiosis Dormancy.

hypocercal tail In fish, a tail in which the lower lobe is more pronounced or larger than the upper lobe.

Hypocolidae *See Hypocolius*.

Hypocolius (hypocolius; family Bombycillidae) Monotypic genus, comprising *H. ampelinus*. This is a blue-grey bird with a black mask, white-tipped black primaries, and a black-tipped tail. Its bill is slightly hooked, and its legs are short and strong. It inhabits open scrub with trees, feeds on berries and insects, and nests in trees and bushes. It is sometimes placed in a family of its own, Hypocolidae. It occurs in SW Asia.

hypocone In the upper molar tooth of mammals, the inside posterior cusp, which corresponds to the outer posterior cusp (hypoconid) of the lower molar.

Hypocreaceae (order Sphaeriales) Family of fungi, which form brightly-coloured, fleshy or leathery perithecia. There are many genera, most of which are saprotrophic and found on plant material, soil, dung, etc. Some can cause disease in plants.

Hypoderma (warble flies) *See* Oestridae.

hypodermis In the leaves of certain plants, the layer of cells immediately below the epidermis. It may be strengthened to provide protection, or may store water.

hypogeal *See* germination.

hypogean Growing or occurring underground.

Hypogymniaceae (order Lecanorales) Family of lichens, in which the thallus is foliose to subfruticose with radiating lobes; the upper surface is typically grey-green. Both surfaces are covered by a cortex. Rhizines are absent. The family are found on a range of substrates in cooler regions. There are four genera, including *Hypogymnia*. *Hypogymnia physodes* is one of the commoner British lichens, and is fairly insensitive to atmospheric pollution.

hypogyny (adj. hypogynous) In flowers, the condition in which the calyx, corolla, and stamens are inserted on the receptacle or axis, below and free from the ovary.

hypolimnion The lower, cooler, non-circulating water in a thermally-stratified lake in summer. If, as often occurs, the thermocline is below the compensation level, the dissolved oxygen supply of the hypolimnion depletes gradually: replenishment by photosynthesis and by contact with the atmosphere are prevented. Re-oxygenation is possible only when the thermal stratification breaks down in autumn.

hyponasty Differential, nastic growth of the lower part of a plant organ, e.g. the growth of the lower side of a leaf so that the leaf blade curves upwards.

hyponeustic *See* zooneuston.

hypophloeodal Growing or living beneath (or within) tree bark.

hypophysial sac (Rathke's pouch) Median pit in the roof of the mouth of vertebrates. In the Agnatha (lampreys and hag fish) it is associated with the nasal pit to form the nasohypophysial sac. In all animals of the superclass Gnathostomata it forms much of the pituitary body.

Hyposittidae (coral-billed nuthatch; order Passeriformes) Monogeneric family whose sole representative, *Hypositta corallirostris*, is a small, blue-grey bird with a short, stout, hook-tipped, coral-red bill and a black face. It feeds on insects by climbing up trees. Sometimes it is included in the Vangidae or the Sittidae. It occurs only in Madagascar.

hypostasis *See* epistasis.

hypostome In hydras, a conical mound at the oral end of the body: it contains the mouth.

hypothallus 1 In myxomycetes which form sporangia, a layer of material upon which sits the sporangium or its stalk. 2 In certain lichens, a layer of fungal tissue beneath the thallus and extending beyond the edges of the thallus.

hypotheres *See* Notoungulata.

hypothesis An idea or concept that can be tested by experimentation. In inductive or inferential statistics, the hypothesis is usually stated as the converse of the expected results, i.e. as a null hypothesis (H_0). This helps workers to avoid reaching a wrong conclusion, since the original hypothesis H_1 will be accepted only if the experimental data depart significantly from the values predicted by the null hypothesis. Working in this negative way carries the risk of rejecting a valid research hypothesis even though it is true (a problem with small data samples); but this is generally considered preferable to the acceptance of a false hypothesis, which would tend to be favoured by working in the positive way.

hypothesis-generating method Term often applied to data-structuring techniques, such as classification and ordination methods which, by grouping and ranking data, suggest possible relationships with other factors. Appropriate data may then be collected to test these hypotheses statistically. For example, a classification or ordination of plant data from a heathland might suggest a relationship with soil-water status. If suitable soil data were then recorded, this hypothesized relationship could be tested.

hypothesis testing Evaluation of a hypothesis using an appropriate statistical method and significance test. *See also* statistical method; and numerical method.

Hypotremata 1 Alternative name for the superorder Batoidimorpha (rays). 2 Older name for the order Rajiformes (rays). *Compare* Pleurotremata.

Hypotrichida (subclass Spirotrichia) Order of ciliate protozoa which are mostly ovoid and flattened, with few or no cilia on the dorsal surface. Cirri occur in groups on the ventral surface. There are three families, and many genera. They are free-living in fresh or brackish water, and feed mainly on bacteria.

Hypoxidaceae Former plant family, whose members are now included in the family Amaryllidaceae.

Hypoxis (family Amaryllidaceae) Genus of herbaceous plants with a bulbous root stock, and long, linear leaves arising from the base of the plant. The inflorescence is an umbel on a long, leafless, flower stalk. There are about 100 species. The genus is represented in America, Africa, E. Asia, and Australia.

Hypoxylon (family Xylariaceae) Genus of fungi, in which the fruit body consists of a stroma in which perithecia are embedded. The fruit body is hard and dark-coloured and is often hemispherical but may be flattened and crust-like. The tips of the perithecia are just visible as tiny warts on the surface. The spores are dark brown. *H. fragiforme* is common from late summer to spring on dead beech wood; the fruit bodies are hemispherical, 0.1–1.0 cm across, crowded, salmon-pink in colour, becoming brick-red and finally black.

Hypseleotris compressus (carp gudgeon) *See* Eleotridae.

Hypsilophodontidae Family of bipedal (ornithopod), ornithischian dinosaurs, ranging from the Upper Triassic to the Upper Cretaceous. *Hypsilophodon* itself, from the Wealden of the Lower Cretaceous, is the most primitive of the ornithopod dinosaurs known to date, despite its relatively late appearance in the Mesozoic fossil record.

Hypsipetes (bulbuls; family Pycnotidae) Genus of medium-sized, olive-brown and yellow birds (although one species is black), many of which have

crests. They have longer wings than other bulbuls, and some are migratory. They inhabit forests, bushy and cultivated areas, and gardens. They feed on fruit and berries, and most nest in bushes and low trees, although some nest high in forest trees. There are 20 species, found in Asia, Madagascar, and the Mascarenes.

Hypsithermal *See* Flandrian.

hypsodont Applied to teeth in which the crowns are high and the roots are short.

hypsographic curve Representation of the respective elevations and depths of points on the Earth's surface with reference to sea-level. On average land projects about 850 m above sea-level and the average depth of ocean basins is 3730 m below sea-level.

hypurals Enlarged ventral ribs, which, in the tail region of teleost fish, support the caudal fin.

Hyracodontidae (order Perissodactyla, superfamily Rhinocerotoidea) One of three families of rhinoceroses, known as the 'running rhinoceroses'. They were small, slender browsers, which first appeared in the Eocene and became extinct in the Lower Miocene. They inhabited the northern continents, and were possibly displaced by ancestors of the horse. They had teeth similar to those of rhinoceroses, but differed from them in having long legs, and three toes on each foot (similar to those of contemporary horses).

Hyracoidea (hyraxes, dassies, conies; cohort Ferungulata, superorder Paenungulata) Order of primitive ungulates. It contains the single family Procaviidae, which are small, gregarious, herbivorous, terrestrial or arboreal mammals, superficially resembling rabbits and occupying similar niches. The hyrax has short ears and no tail. The forelimb has four digits and the hind limb three. The second digit of the hind limb has a long claw, used possibly for grooming or for climbing, the remaining digits have hoof-like nails. The gait is plantigrade. The single pair of upper incisors grow continually and are used for defence; the lower incisors are comb-like and are used in grooming. The intestine has chambers containing symbionts which digest cellulose. A variety of ancestors, some the size of small horses but others similar to modern forms, are encountered first in the Lower Oligocene of N. Africa: they lived throughout the Tertiary, so modern hyraxes may be very similar to early small ungulates. There are about five species, in three genera: *Procavia* and *Heterohyrax* (rock hyraxes), and *Dendrohyrax* (tree hyrax). These are distributed throughout Africa, the Mediterranean region, and Arabia, some living in deserts, where they survive with very little water.

Hyracotherium Known formerly as *Eohippus* (the 'dawn horse'), the earliest known Perissodactyl, which is placed in the family Equidae. It was only 27 cm high, the size of a fox terrier: it was short-faced with low-crowned cheek teeth, and had four toes on the forefeet, and three on the hind. Abundant in the Early Eocene of N. America and Europe, it was recently discovered in Palaeocene deposits in Mongolia. It was a browser dwelling in forest glades, and the likely ancestor for all the horses. Because of its small size, when the fossils were first found they were mistakenly associated with the African hyraxes, hence the name. In America the fossils were identified correctly and the name '*Eohippus*' was adopted, but according to the rules of taxonomic nomenclature '*Hyracotherium*' takes precedence.

hyrax *See* Hyracoidea.

hyssop *See Hyssopus*.

Hyssopus (hyssop; family Labiatae) Genus of aromatic perennial herbs, which are woody below, with narrow to linear leaves, and flowers in whorls. The calyx is 15-nerved, with five nearly equal teeth, and a two-lipped corolla. Formerly hyssop was much used as a flavouring, and sometimes grown for ornament. There are six species, of Mediterranean origin.

Hystricidae (Old World porcupines; order Rodentia, suborder Hystricomorpha) Family of mainly vegetarian, burrowing rodents in which some body hairs are modified to form spines. The body is thickset; the legs are short, with five digits, the first digit of the forelimbs being reduced. The tail is long in some species and bears modified spines. Old World porcupines are slow-moving, relying for defence on their colouring and on the noise made by the movement of their spines. The hystricoid arrangement of the jaw muscles probably evolved independently in Old and New World porcupines (Erethizontidae), so these are not necessarily related closely. There are four genera, with about 16 species of Old World porcupines: they are distributed through Africa, Italy, and S. Asia.

Hystricomorpha (cohort Glires, order Rodentia) Suborder comprising many families of rodents, in which the medial masseter muscles spread forward through the infra-orbital canal, while the lateral masseter is attached to the zygomatic arch, as in primitive rodents. The suborder includes the Old World porcupines, the New World porcupines, guinea-pigs, capybara, agoutis, vizcacha, and mole-rat.

I

IAA *See* indole-acetic acid.

Iapetus Ocean *See* Caledonian orogeny.

Ibalia *See* Ibaliidae.

Ibaliidae (suborder Apocrita, superfamily Cynipoidea) Family comprising a small and rare group of insects, parasitic on members of the Siricidae, and containing some of the largest Cynipoidea (up to 15 mm long) and those with the most complex wing venation. Adults are black and yellowish-brown, with an elongate and laterally compressed abdomen, the gaster being almost sessile. The forewing has brownish spots medially and apically. Members of the genus *Ibalia* are important parasitoids of *Uroceras* (woodwasp), the only European species being 10 mm long and black and brown in colour. The abdomen is laterally flattened like a knife edge, and the ovipositor is curled up beneath in a sheath. The sensitive antennae of the ibaliids seek out the tunnels made by the woodwasp, and eggs are laid in the body of the host.

Ibis (wood storks; family Ciconiidae) Genus of white storks which have black primaries and a black tail, and a bare head with red, yellow, or blackish skin. They have a very long, thick, and decurved yellow bill. They inhabit swamps and open country, feed on insects and vertebrates, and nest in trees. They are often placed in the genus *Mycteria*, with *M. americana* (wood stork). There are three species, found in Africa and Asia.

ibises *See* Ciconiiformes; *Threskiornis*; and Threskiornithidae.

IBP *See* International Biological Programme.

Icacinaceae Family of trees, shrubs, woody climbers, and a few herbs, in which the leaves are simple, usually alternate, and without stipules. The flowers are mostly unisexual and tetra- or pentamerous, and the ovary is trilocular. The fruits are mostly drupes. There are 58 genera, with 400 species, occurring in the tropics, mostly in rain forests.

Icarosaurus siefkeri As the generic name suggests this animal is a flyer, or more precisely a glider. It is a member of the lizard family, recorded from the Upper Triassic of N. America. *Icarosaurus*, like *Kuehneosaurus*, had horizontal 'sails' and possessed the ability to glide from trees or rock outcrops to the ground. It was similar to the flying lizard *Draco*.

ice blink Whitish appearance seen above the horizon, caused by light reflection over an ice or pack-ice surface.

ice cap Ice mass less than 50 000 km^2 in size, but large enough to submerge the underlying topography and whose flow behaviour is a consequence of its size and shape. It consists of a central ice dome together with outlet glaciers radiating from the periphery.

ice cauldron *See* glacial breach.

ice crystal Frozen water composed of crytalline structures, e.g. needles, dendrites, hexagonal columns, and platelets. Ice clouds are composed almost entirely of ice crystals.

ice fish *See* Channichthyidae; and Salangidae.

Iceland low The region of the N. Atlantic in which the average value of atmospheric pressure is low, owing to the frequency of low-pressure systems (cyclones or 'depressions') moving into and occupying the region. Any one of these systems, when present on an individual day, may be called 'an Iceland low', but the term is used mostly to describe the statistical or climatic feature.

Iceland moss Common name for the lichen *Cetraria islandica*. The thallus is erect and tufted, with flattened, shiny, reddish-brown to brown branches bearing small spines on the margins. It is found on moors in N. Britain and in temperate-alpine regions. The lichen is edible and can be used for example to make jellies.

Icelidae (sculpin; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish with a broad head, narrow tail, large eyes placed on top of the head, and wide mouth in line with the flat belly. Closely related to the true sculpins (family Cottidae) and often placed with them, the icelid sculpins are sluggish, bottom-dwelling fish preferring a cold-water habitat. *Icelinus filamentosus* (threadfin sculpin), 27 cm, is one of the larger species of the N. Pacific. There are about ten species, found in the N. Atlantic and N. Pacific.

Icelinus filamentosus (threadfin sculpin) *See* Icelidae.

ice nucleus Crystalline, microscopic particle, either of ice or of some foreign substance, which can induce the growth of ice crystals upon it from saturated air in cloud at temperatures of the order of −25 °C or below. Deposition of water in this way —directly from vapour to form ice, without forming liquid in between—is called 'sublimation'. During growth, splintering of the crystals (e.g. as a result of updrafts) causes large numbers of new nuclei to be formed. Freezing nuclei are any nuclei, commonly ice crystals but sometimes the suitably shaped crystals of other substances, that when present in clouds at temperatures below 0 °C will cause any supercooled droplets with which they collide to change to ice (in the form of a crystalline growth upon the nucleus). *See also* nucleus.

ice wedge Tapering, vertically-layered mass of ice, about a metre wide at the top and extending

downward for some 3–7 m. It results from contraction cracking of the ground during extreme cold, followed by water penetration from the active layer and subsequent freezing. It is characteristic of uniform sediment, such as river alluvium, under periglacial conditions.

Ichneumonidae (ichneumon wasps; suborder Apocrita, superfamily Ichneumonoidea) One of the largest insect families, comprising a very diverse and highly successful group, each subfamily or tribe of which is parasitic on a particular group of insects. Many species are important as biological control agents, parasitizing larvae and pupae of endopterygote insects, and others parasitize spiders and the egg sacs of spiders and pseudoscorpions. Ichneumonids are medium to large (3–40 mm long) wasps, yellowish to black, or brightly patterned with black and brown or black and yellow. Most species have a long ovipositor but do not sting, although they may make 'stinging' motions if handled.

ichneumon wasps *See* Ichneumonidae.

Ichthyoboridae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish which have a rather elongate body, a single dorsal as well as an adipose fin, a forked tail-fin, large eyes, and a somewhat produced snout. There are many species, found in Africa.

ichthyology The study of fish. Originally this involved research on anatomy, classification, and the general biology of fish, but more recently research topics have included fish culture, fish diseases, conservation, and commercial fisheries.

Ichthyophiidae (ichthyophids; class Amphibia, order Apoda (Gymnophiona) Family of amphibians, in which the adults are terrestrial and have functional eyes and a small tail. Eggs are laid on land. The gilled, aquatic, larval stage is of variable duration before metamorphosis. Adults burrow but feed on the surface at night, eating earthworms, arthropods, and small vertebrates. There are 43 species, occurring in the New World tropics, S. Asia, and Australia.

Ichthyopterygia *See* Euryapsida.

Ichthyosauria (class Reptilia, subclass Ichthyopterygia) Order of so-called 'fish lizards', and the only order in the subclass; the first members of the group date from the Triassic and were primitive in type. The typical, shark-like form, *Ichthyosaurus*, appeared in the Jurassic, when the group in general was especially common. Ichthyosaurs disappeared before the end of the Cretaceous.

Ichthyostega Amphibians in the form of *Ichthyostega* and *Ichthyostegopsis* first appear in the Upper Devonian. *Ichthyostega* shows refinements of the skull, and the development of strong limbs. It retains a long, rather fish-like tail, and links with the crossopterygian fish are confirmed by the presence of teeth with a labyrinthine infolding of the enamel. *Ichthyostega* grew to just under 1 m in length.

icosahedral Applied to a symmetrical object with 20 triangular sides. The virions of many types of virus show icosahedral symmetry.

Icosteidae (ragfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of large (more than 2 m) marine fish, which have a blunt snout, small eyes, and a distinct hump in front of the dorsal fin. The dorsal and anal fins are long, the pectoral fins are absent in adults. *Icosteus aenigmaticus* (ragfish) shows a considerable difference between the juvenile and adult stages, juveniles possessing a very deep body. Icosteidae occur in the N. Pacific.

Icosteus aenigmaticus (ragfish) *See* Icosteidae.

Icteridae (New World blackbirds, orioles, cowbirds; order Passeriformes) Diverse family of black, or black with brown, or orange, or red, or yellow birds, many of which have white wing markings. The bill is short and heavy to long and slender; the wings usually long and pointed, but some short and rounded; the tail variable. Icteridae are arboreal or terrestrial, gregarious or solitary, and feed on fruit, insects, and small vertebrates. Their nests vary from open and cup-shaped to domed, and are built on the ground, or suspended in trees, or in tree cavities. Some are colonial breeders, and many are migratory. There are 22 genera, with about 93 species, found in N., C., and S. America, and the W. Indies.

Icterus (orioles, troupial; family Icteridae) Genus of black and orange, or yellow and white birds, which have narrow, conical bills. They are mainly arboreal; feed on fruit, berries, and insects; and build nests which are globular with side openings, or open cups suspended between branches. There are 24 species, many migratory, found in N., C., and S. America, and the W. Indies. *I. galbula* (northern oriole) has occurred as a vagrant to Europe.

Icterus galbula (northern oriole) *See Icterus*.

ICZN *See* International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature)

-idae Standardized suffix used to indicate a family of animals in the recognized codes of classification, e.g. 'Felidae', the cat family (including lions, tigers, lynxes, pumas, etc.), and 'Canidae', the dog family (including foxes, jackals, and wolves).

Idiacanthidae (black dragonfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of deep-sea fishes which have an elongate, eel-like body. The dorsal and anal fins are long, the pectorals are absent in adults. The long chin barbel of *Idiacanthus fasciola* (dragonfish) is very typical. There are about three species, living worldwide at depths of 100–2000 m.

Idiacanthus fasciola (dragonfish) *See* Idiacanthidae.

idiothetic Applied to information concerning its orientation in an environment obtained by an animal by reference to a previous orientation of its body, and without external spatial clues. *Compare* allothetic.

-iformes Suffix often used, but not recommended by the ICZN code, when a name refers to an order of animals, e.g. 'Strigiformes', the owls.

igneous Applied to one of the three main groups of rock types (igneous, metamorphic, and sedimentary), to describe those rocks that are considered to have been originally molten. The major part of the Earth's rocks are igneous.

ignimbrite Volcanic rock formed as a result of pyroclastic ash flow. Varieties are classified as welded or non-welded, depending on the microscopic texture of glassy fragments. The extent of welding is controlled by the temperature of the flow, the gas content, and any superincumbent loading. A nuée ardente (cloud of lava fragments) is a possible source of ignimbrite deposits.

Iguana iguana (common iguana, green iguana; order Squamata, suborder Sauria (Lacertilia), family Iguanidae) Large lizard (up to 1.8 m long) which is principally herbivorous, with a short fleshy tongue, and serrated teeth. A throat dewlap is present. There is a spiny crest along the back. *I. iguana* dives into water if startled. It occurs in S. American tropical forests.

Iguanidae (iguanas, basilisks, anoles; order Squamata, suborder Sauria (Lacertilia) Family of lizards, which includes terrestrial, arboreal, burrowing, and semi-marine forms, the counterparts of the Old World Agamidae, but distinguishable by their pleurodont teeth (on the inside of the jaw). Typically they are long-limbed and agile. Dorsal crests, throat appendages, and 'helmets' are common. There are more than 700 species, found mainly in the New World, but also in Madagascar and some Pacific islands. *See Amblyrhynchus cristatus*; *Anolis*; *Basiliscus*; *Iguana iguana*; and *Phrynosoma*.

Iguanodontidae Jurassic–Cretaceous family of bipedal (ornithopod), ornithischian dinosaurs, whose best-known representative is *Iguanodon*, remains of which have been found in Europe, Asia, and Africa.

ileum In Mammalia, the final part of the small intestine.

Ilex (family Aquifoliaceae) Genus of trees and shrubs, in which the leaves are leathery, and mostly evergreen. The flowers are usually tetramerous. The fruit is a berry. The genus includes ornamentals (holly is mainly *I. aquifolium*), and the source of yerba maté, a tea-like infusion from the leaves of *I. paraguariensis*. Several have close-grained, white timber. There are 400 species. Their distribution is cosmopolitan, but they are absent from N. America.

ilium In tetrapods, the dorsal section of the pelvis, which articulates with one or more sacral vertebrae.

Illecebraceae Alternative name for the Paronychieae tribe of the plant family Caryophyllaceae.

Illiciaceae *See Illicium*.

Illicium Sole genus of the family Illiciaceae, related to the Winteraceae, and comprising shrubs and small trees in which the leaves are simple, sometimes occurring in pseudowhorls. The flowers are regular, with numerous spiral parts. The fruit consists of spreading follicles. There are 42 species, occurring in SE Asia, N. America, and the W. Indies.

illicium *See* Linophrynidae.

illite (hydrous mica) Very common and widely occurring soil-clay mineral.

illuviation Process of deposition (in-washing) of soil materials, either from suspension or solution, and usually into a lower horizon, after removal from above or from a lateral source.

ilmenite Mineral, specific gravity 4.5–5.0, hardness 5.0–6.0, and with the chemical composition $FeTiO_2$, whose name is derived from that of the Ilmen Mountains, USSR. It occurs as an accessory mineral in igneous rocks, e.g. gabbro and diorite; and also in quartz veins and pegmatites, in gneisses, and in association with haematite and chalcopyrite. It is resistant to weathering, and is found extensively in alluvial deposits with magnetite, monazite, and rutile. It is distinguished by its magnetism and streak. It is black with a black to brownish-red streak, and has a sub-metallic lustre. It crystallizes in the trigonal system. The crystals are normally thick and tabular, but it is often massive and compact. It is used as a source of iron and titanium.

imago The fully developed adult among pterygote insects.

Imbricata (class Eocrinoidea) Order of eocrinoids, restricted to the Lower Cambrian, in which the lower part of the theca and the stalk (or holdfast) are composed of imbricate plates which lack surface structures (epispires).

imbricate With parts overlapping one another like tiles. *See also* valvate.

imbricate structure Fabric resulting from the stacking of fragments, particles, or structures. Some pebble beds show an imbricate structure, with the pebbles leaning in the direction of the current. *See also* bar.

imino acid Acid derived from an imine in which the nitrogen of the imino group and the carboxyl group are attached to the same carbon atom. Proline and hydroxyproline are imino acids, normally classified with amino acids.

imitation The acquisition of patterns of behaviour by repeating similar behaviour observed in others, not necessarily of the same species.

immigration In genetics, the movement or flow of genes into a population, caused by immigrating individuals which interbreed with the residents. This is the usual source of new variation in a population, although the fundamental sources of all variation are gene mutation and recombination.

immobilization Conversion of a chemical compound from an inorganic to an organic form as a result of biological activity; the compound is thereby removed from the reservoir of compounds available to plant roots.

immunity Natural or acquired resistance of an organism to a pathogenic micro-organism, or its products.

immunodiffusion Commonly-used test for the existence of an antibody–antigen reaction. It involves the diffusion of known antibodies and suspected antigens through agar, and the identification of a zone of precipitation.

immuno-electrophoresis Technique for the differentiation of proteins in solution, based on both their electrophoretic and immunological properties. Initially the proteins are separated by gel electrophoresis: they are then reacted with specific antibodies by double diffusion through the gel. The pattern of precipitating arcs thus formed can be used to identify the proteins.

immunoglobin *See* antibody.

impala (*Aepyceros melampus*) *See* Bovidae.

impark (empark, inpark) To enclose land to make a park; to fence land.

Impatiens (balsam, touch-me-not) *See* Balsaminaceae.

Imperata (family Gramineae) Genus of plants which includes *I. cylindricum*, a noxious, weedy, fire-resistant grass of tropical Africa and Asia, which has tough rhizomes. There are 10 species, occurring in the tropics and subtropics.

imperfect state The asexual state of a fungus, i.e. the state in which no sexual reproduction occurs.

imperforate nostrils *See* perforate nostrils.

imperial pigeons *See Ducula*.

impetigo Highly infectious disease of the skin (generally on the face), which occurs in children. Inflamed lesions are covered by light yellowish crusts. It may be caused by any of several different bacteria, including *Staphylococcus aureus* and *Streptococcus pyogenes*.

importance value *See* density–frequency–dominance measure.

imprinting General descriptive term for a form of learning that only occurs early in a young animal's life. In it, the attention of the young becomes focused on a particular moving object, usually the mother. The phenomenon was first described in detail by Konrad Lorenz in 1937 in respect of precocial birds, in which it is most strongly developed. In this case imprinting occurs only during a brief critical period, possibly of only a few hours, very early in the life cycle. Such imprinting is irreversible and influences subsequent behaviour patterns, most importantly sexual behaviour.

-ina Customary suffix, not specifically cited in the code of nomenclature, that indicates an animal subtribe.

Inachis io (peacock butterfly; order Lepidoptera, family Nymphalidae) Butterfly in which adults have a prominent eye-spot on each of the red-brown wings. The under-sides of the wings are blackish. Larvae feed in groups on stinging nettles. Early instars spin silk webs over the terminal leaves. the butterflies overwinter as adults. The species is found in Europe, including Britain except N. Scotland, and temperate Asia.

Inadunata (class Crinoidea) Extinct subclass of crinoids in which the arms were completely free and in no way incorporated into the calyx. The mouth and ambulacral cavities were roofed over by a series of small plates. They range from Lower Ordovician to Upper Permian in age.

-inae 1 Standardized suffix used to indicate a ranking of plants at the subtribe level in the recognized code of classification. 2 Standardized suffix used to indicate a subfamily of animals in the recognized code of classification.

Inarticulata (phylum Brachiopoda) Class of brachiopods with chitinophosphatic or calcareous valves held together only by muscles and the body wall, and not hinged. The valves may be punctate or impunctate. There is no internal skeletal support for the lophophore. The pedicle is developed from the ventral mantle. The alimentary canal has a functional anus. Inarticulata first appeared in the Lower Cambrian.

inborn error Genetically-determined biochemical disorder that results in an enzyme defect: this produces a metabolic block and has pathological consequences. Two examples in humans are phenylketonuria, in which tissue degeneration results from the accumulation of a toxic intermediate in the pathway of tyrosine metabolism, and Wilson's disease, in which death results from poisoning by copper because of a blockage in the pathway of copper detoxification. In both cases a single nucleotide substitution has produced a recessive allele that interferes with a metabolic pathway and causes death of the homozygotes.

inbreeding Interbreeding of closely related individuals. In animals, such individuals might be siblings, or cousins, or a parent and its offspring; in plants, the process implies self-fertilization. The converse is outbreeding, which involves the mating of distantly related individuals. The inbreeding coefficient is the probability of homozygosity due to a zygote obtaining copies of the same gene from parents of common ancestry. Inbreeding increases homozygosity: unfavourable recessive genes are therefore more likely to be expressed in the offspring. In general, the genetic variability of an inbred population declines; this is usually disadvantageous for its long-term survival and success. Typically, vigour is reduced in inbred stock. Many organisms, including humans, have physical or social mechanisms that tend to discourage inbreeding and promote outbreeding.

inbreeding depression Decreased vigour in terms of growth, survival, or fecundity, following one or more generations of inbreeding. This is the opposite outcome to that obtained by the crossing of two separate inbred lines. *Compare* heterosis.

incense cedars *See Libocedrus*.

Inceptisols Mineral soils (an order of the USDA Soil Taxonomy) that have one or more horizons in which mineral materials have been weathered or

removed. Inceptisols are in the early stages of forming visible horizons, and are only beginning the development of a distinctive soil profile. The term embraces brown earths.

inch worms *See* Geometridae.

incised meander *See* meander.

incisiform Chisel-shaped, resembling an incisor.

incisor In Mammalia, chisel-shaped teeth at the front of the mouth. In primitive forms there are three on each side of each jaw.

inclusive fitness The true measure of the fitness of an organism is often considered to reside not merely in the individual organism's own success, but also in the success of all its kin, i.e. those bearing some portion of the same genotype. J. B. S. Haldane is reputed to have said once that he would lay down his life for more than two brothers or sisters, eight cousins, 32 second cousins, etc., these numbers corresponding to the proportions of his own genes shared by these relatives.

incompatibility (ethol.) Term for the relationship between patterns of behaviour that cannot be performed simultaneously, because they are contradictory, because they require the simultaneous operation of reflexes that are mutually inhibitory, or because they are based on contradictory motivation.

incomplete dominance In genetics, the situation of partial dominance in which a heterozygote shares a phenotype that is quantitatively intermediate between those of the corresponding homozygotes.

inconsequent drainage (insequent drainage) *See* drainage.

increment borer (tree-borer, Pressler borer) Tool used to bore and extract a thin cylinder of wood (a core) from a living tree, without damaging the tree.

incubous (of liverwort leaves) *See* Jungermanniales.

Incurvariidae (order Lepidoptera) Family of small, primitive, drab or metallic moths. The antennae are very long in some species. The ovipositor is extensible and used to lay eggs in leaves or stems. Larvae are leaf-miners or stem-borers, or live in galls or among detritus. Frequently they construct cases from leaf litter or from excisions from leaves. They have a wide distribution.

incus From the Latin *incus*, meaning 'anvil'. **1** In Mammalia, the central auditory ossicle of the middle ear, derived from the quadrate bone of ancestral vertebrates. **2** A supplementary cloud feature comprising the flattened, anvil-like shape of the top of cumulonimbus cloud. *See also* cloud classification.

indehiscent Applied to fruits, e.g. berries, that do not open to release their seeds.

independent assortment (random assortment) The random distribution in the gametes of separate genes. If an individual has one pair of alleles *A* and *a*, and another pair *B* and *b* (this genotype being represented as *AaBb*), then it should produce equal numbers of four types of gametes: *AB*, *Ab*, *aB*, and *ab*. The assortment of alleles of one gene occurs independently of that of the alleles of the other gene. This is found experimentally with many pairs of genes, and is asserted in Mendel's second law, known as the law of independent assortment: in fact, though, it applies only to distantly linked or unlinked genes.

index fossil Fossil that is characteristic of a particular unit of rock and is used to denote the zone in which it occurs. *See also* zone.

Indian bean (*Catalpa bignonioides*) *See Catalpa*.

Indian floral region Part of Good's Indo-Malaysian subkingdom within his Palaeotropical kingdom, and more a region of floral mixing than a distinct entity, notwithstanding the extent of the subcontinent. There are only about 150 endemic genera, and most of these are monotypic. Many varied and useful plants are thought to be native to the region.

Indian glass fish (*Chanda ranga*) *See* Centropomidae.

Indian Ocean One of the world's major oceans, lying between Africa, India, and Australia. It has a surface area of 77 million km^2 and an average depth of 3872 m. The ocean receives a great deal of sediment from three of the world's major rivers (the Ganges, the Indus, and the Brahmaputra).

Indian spinach (*Basella alba*) *See Basella*.

Indian summer *See* singularity.

Indian variable lizard *See Calotes versicolor*.

Indicator (honeyguides; family Indicatoridae) Genus of mainly grey, olive, brown, and white birds, which have white outer tail feathers. They are nest parasites of a wide range of species, and are found in forest and woodland. They feed mainly on beeswax. There are 10 species found in Africa and Asia.

indicator (geomorph.) *See* erratic.

Indicatoridae (honeyguides; order Piciformes) Family of grey, olive, brown, and white birds which have short, stout bills, and short legs with zygodactylous toes. Their skin is thick and so protects them against insect stings. They are arboreal, and found in forest and woodland; they feed on beeswax and insects, and are nest parasites. Their common name refers to their habit of guiding animals to bee nests, where they feed on the remains left by the animals that have plundered them. There are four genera, with 14 species, found in Africa and Asia.

indicator species **1** Species that is of narrow ecological amplitude with respect to one or more environmental factors and that is, when present, therefore indicative of a particular environmental condition or set of conditions. In geobotanical surveys, species or ecotypes with high heavy-metal tolerance have been used as metallic-ore indicators. **2** In plant-community classification, the term is used more loosely to denote the most characteristic community members. In this case 'indicator species' may include species typical of and vigorous

in a particular environment and is not necessarily restricted to species of narrow ecological amplitude. *See also* geobotanical exploration.

indicator-species analysis In general, a classificatory scheme in which the final groups are characterized by indicator species derived from the data in the course of group definition. More specifically, the term refers to a polythetic-divisive classificatory scheme proposed by M. O. Hill (1975). Sites are ranked by a reciprocal averaging ordination and divided into two groups at the mid-point—the 'centre of gravity'—of all the weighted data values of the ordination. Indicator species (usually five) are then identified as those species exclusively, or most nearly so, associated with one or other side of this division (positive and negative indicators). The site-indicator scores, effectively a rough secondary ordination, determine their final classification; and the process may then be repeated within the groups identified. The indicator species form a key, enabling new sites to be added easily into the classificatory framework without excessive recalculation.

indifferent species Species with no real affinity for any particular community, but that is not rare (as an accidental species would be). It is fidelity class 2 in the Braun-Blanquet phytosociological scheme. *Compare* accidental species; exclusive species; preferential species; and selective species.

indigenous *See* native.

indigo *See Indigofera*.

Indigofera (family Leguminosae, subfamily Papilionoideae) Genus of small, shrubby or herbaceous legumes, adapted to dry conditions and having small, xeromorphic leaves. The seeds are dispersed in an explosive manner. The dye indigo can be extracted from the plants. There are 700 species, and the genus is represented in all arid zones of the world.

indirect flight muscle The thoracic musculature that brings about the flight movements of the wings in most insects. It is not attached directly to the wings. The thorax is a box to which the wings are joined. Longitudinal muscles compress the thoracic box and cause the wings to move down. Dorsoventral muscles pull the tergites and sternites of the thorax together, causing the wings to move upwards.

individualistic hypothesis View, first proposed by H. A. Gleason (1917, 1926), that vegetation is continuously variable in response to a continuously varying environment. Thus no two vegetation communities are identical. It implies also that vegetation cannot be classified, and that recognition of particular individual communities will be difficult (the problem arising because of the difficulty of defining boundaries). This viewpoint underlies one of the two polarized approaches to the description and analysis of vegetation communities that were much debated in the 1950s and 1960s. The individualistic hypothesis favours a continuum view of vegetation, for which ordination rather than classification methods are appropriate. *Compare* organismic.

indole-acetic acid (IAA) Substance that acts as a growth hormone or auxin in plants, where it controls cell enlargement and, through interaction with other plant hormones, also influences cytokinesis.

Indo-Malaysian rain forest Formation of the rain forest found in W. India and Ceylon, and peninsular SE Asia, together with the adjacent archipelago. It is differentiated from the other rainforest formations by its floristic composition. Large areas of the Indo-Malaysian rain forest have been cleared. *See* African rain forest.

Indostomidae (class Osteichthyes, subclass Actinopterygii, order Indostomiformes) Monospecific family of very small (3 cm) freshwater fish with a slender body, large eyes and pointed snout. The one species, *Indostomus paradoxus*, found in Burma, has been placed in an order (Indostomiformes) of its own.

Indostomiformes *See* Indostomidae.

indri *See* Indriidae.

Indriidae (indri, sifaka; order Primates, suborder Strepsirhini) Family of primitive primates, which includes the largest of the living lemurs (up to 1 m long). Its members are distinguished from other lemurs by the absence of the lower canine, and by having one upper and one lower premolar tooth. The tail is short in some species, and the ears may be concealed beneath long hair on the sides of the head. They are fully arboreal although they visit the ground, and are exclusively vegetarian. There are four species in three genera: *Indri* (indri), *Propithecus* (sifaka), and *Avahi* (woolly indri). They are all confined to Madagascar.

induced-fit theory Variation of the lock-and-key theory of enzymatic function. It is proposed that the substrate causes a conformational change in the enzyme such that the active site achieves the exact configuration required for a reaction to occur. The overall effect would be a tighter binding for the substrate and enzyme.

induration Process of forming indurated horizons or hardpans that have a high bulk density and are hard or brittle. Cementing materials may be present and responsible for the induration.

indusium The covering of the sorus of a fern.

industrial melanism Development of melanic forms of organisms in response to soot and dust pollution. Industrial melanism is especially associated with various moth species and was first noted early in the nineteenth century. In the 1950s, studies by H. B. D. Kettlewell on the moth *Biston betularia* showed that melanism is a simple inherited trait favoured by natural selection in soot-polluted environments, where dark colouring gives better camouflage and so better protection from predators. In time the proportion of melanic forms increases in such polluted environments. The reverse process —selection in favour of pale forms—occurs in pollution-free environments where the paler, speckled form is better concealed on the tree lichens on which it settles. With appropriate calibration,

the extent of melanism in a population may thus be used as an indicator of industrial soot pollution.

infantile paralysis *See* poliomyelitis.

infauna Benthic organisms that dig into the sea-bed or construct tubes or burrows. They are most common in the subtidal and deeper zones. *Compare* epifauna.

infection Invasion of the tissues of a plant or animal by a pathogenic micro-organism. Sometimes the term is used as a synonym for a disease caused by a micro-organism.

infectious Applied to a disease that can be transmitted from one individual to another.

infectious jaundice (Weil's disease) *See Leptospira*.

infiltration Downward entry of water into soil.

inflorescence Flowering structure consisting of more than a single flower.

influenza (flu) Acute, highly infectious, normally self-limiting disease of the respiratory tract, which tends to occur in epidemics. Symptoms include headache, fever, prostration, and cold-like symptoms (coryza). The causal agent is a virus of the influenza virus group.

influenza viruses Group (genus) of viruses within the orthomyxovirus group. Influenza viruses cause not only human influenza but also diseases such as fowl plague and swine influenza. Some influenza viruses continually undergo changes in their antigenic characteristics, and this is responsible for the sudden epidemics of influenza.

information analysis An agglomerative classificatory scheme for describing vegetation communities. It uses the information statistic as the basis for the joining of groups.

information index *See* Shannon–Wiener index of diversity.

information statistic Measure of disorder within a group, which is zero when all individuals within the group are identical. In information analysis—an agglomerative, hierarchical classificatory technique, devised by W. L. T. Williams and others, 1966—a hierarchy is constructed by repeatedly joining together those individuals or groups which exhibit the smallest increase in heterogeneity (disorder), and therefore the smallest change in information.

informosome *See* maternal message.

infralittoral In marine ecology, a term sometimes used to distinguish the intertidal region exposed only at the lowest, i.e. equinoctial, tides. It lies between the medio- and circalittoral zones. In the more widely used shore-zonation scheme it corresponds to a transitional area between the littoral and sublittoral zones. In this zone *Zostera* species are very characteristic plants on soft substrates, with corals being common on rocky shores. The brown seaweeds (*Laminaria* species) start to become abundant in this zone.

infra-orbital foramen Canal in the maxilla, below and anterior to the orbit, through which nerve fibres and blood vessels pass to the face.

infructescence Fruiting structure comprising more than one fruit.

infundibuliform Shaped like a funnel.

infundibulum 1 In Ctenophora, a part of the gastrovascular cavity from which the radial canals originate. 2 In vertebrate embryos, an outpushing from the floor of the brain which, together with the hypophysis, develops into the pituitary body.

infusoria Old term for the teeming microscopic organisms, particularly protozoa, found in hay infusions.

inhibition The complete abolition of, or the decrease in the extent or rate of, an action or process.

-ini In classification by the nomenclature code, the recommended, but not mandatory, suffix used to indicate a tribe of animals.

Iniomi Older name for a group of fish now placed in the order Myctophiformes.

initiator Transfer ribonucleic acid (tRNA), that in eukaryotes carries methionine and in prokaryotes *N*-formylmethionine, that binds to the small unit of a ribosome bearing messenger ribonucleic acid (mRNA), thus forming an initiation complex. This, in the presence of three protein initiation factors and GTP which is hydrolysed, enables the larger ribosomal subunit to associate with the complex and peptide-chain synthesis to proceed.

ink cap Common name for any *Coprinus* fruit body in which the gills of the fungus undergo autodigestion, dissolving into a black, ink-like fluid.

inland sea Extensive body of water that is largely or wholly surrounded by land. Any connection to the open ocean is restricted to one or a few narrow sea passages. Examples of such areas are the Baltic and the Mediterranean Seas.

inlier Structure where older rocks are surrounded completely by newer rocks. It may result from faulting or folding followed by erosion.

innate 1 Applied to behaviour that is not learned (i.e. behaviour that is acquired genetically). 2 Applied to behaviour that may be learned but that has evolved by natural selection. In this case, parents behave in a particular way, and teach their offspring to behave likewise, and are more likely for this reason to reproduce successfully. The term is regarded by many ethologists as obsolete because it fails to allow for the modification of patterns of behaviour in response to environmental factors.

inner veil *See* partial veil.

Inocarpus (family Leguminosae, subfamily Caesalpinoideae) Genus of trees in which the leaves are simple. The flowers are regular with five narrow petals. The pod is stout, leathery, and indehiscent, with one big seed, which is edible in *I. fagiferus* (Tahitian chestnut). There are four species, occurring from Malaya to the Pacific islands.

Inocybe (family Cortinariaceae) Genus of fungi in which the fruit bodies are small, dull-coloured, and mushroom-shaped, with conical or umbonate caps.

This is one of the commonest and largest genera of fungi in the world; however, identification of the species frequently requires microscopic examination of the spores. Most species grow on the ground. Some are very poisonous; none is edible.

inositol Carbocyclic or sugar alcohol, widely distributed in both plants and animals. It is often classed with the B vitamins as it has been reported to be essential in the diets of some organisms.

Inovicellata (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans, in which the slender stolons have a creeping habit and give rise to separate, upstanding individuals which possess opercula. The division occurs from the Eocene to Recent.

inpark *See* impark.

inquilines *See* Cynipidae.

Insecta (Hexapoda, insects; phylum Arthropoda) Class of arthropods that have three pairs of legs and, usually, two pairs of wings borne on the thorax. Typically, there is a single pair of antennae and one pair of compound eyes. Gas exchange takes place through a tracheal system and the gonoducts open at the posterior end of the body. The oldest fossil insects occur in Devonian rocks, and the first winged representatives are known from Carboniferous rocks. Dragonflies and beetles were established before the end of the Palaeozoic; social varieties such as ants and wasps are present in Cretaceous sediments. The evolution of the flowering plants had a marked influence on insect development, so that many new forms appeared in the Cretaceous and Tertiary Periods. More than 750 000 extant species of insects have been described. This is larger than the number of species belonging to all other animal classes combined.

insecticide Chemical substance, natural or synthetic, that kills insects. Natural insect poisons include pyrethrum and rotenone (derris). The main synthetic toxin groups are organochlorines (e.g. DDT), organophosphates (e.g. malathion), and carbamates (e.g. carbaryl).

Insectivora (infraclass Eutheria, cohort Unguiculata) Order that includes the ancestors of all eutherian mammals, grouped in four suborders: Proteutheria, comprising many extinct forms and the surviving tree shrews (sometimes separated as Scandentia); Macroscelidea, the elephant shrews; Dermoptera, the colugo; and Lipotyphla, the living hedgehogs, shrews, and moles. These are nowadays more usually separated into different orders, the order Insectivora being disbanded. Insectivores are usually small, nocturnal animals showing many primitive features. The dentition is usually full; the teeth resemble those of the earliest mammals. The bony palate is incomplete. In many groups the tympanic cavity is open with no ossified bulla, the tympanic bone forming a partial ring. Limbs are pentadactyl; the gait plantigrade. The brain has large olfactory bulbs but the cerebral hemispheres are small and little convoluted. The stomach is simple. The snout is very sensitive, in some species being drawn into a small trunk. Vibrissae are present on the snout and elsewhere on the body. The sense of hearing is acute, but the eyes are small and eyesight is poor. Some insectivores retain the cloaca. The reproductive system has diverged from the early eutherian form. Fossil forms are known from the Cretaceous and Palaeocene.

insects *See* Insecta.

inselberg Steep-sided, isolated hill that stands above adjacent nearly-flat plains. It may have a narrow pediment at its base, or elsewhere may be surrounded by a shallow moat. Locally, flared or steepened margins occur. It is best developed under a savannah climate. *See also* bornhardt.

insequent drainage (inconsequent drainage) *See* drainage.

inseveralty *See* severalty.

insolation The amount of incoming solar radiation that is received over a unit area of the Earth's surface. Solar energy received over the planet's surface varies according to season, latitude, transparency of the atmosphere, and aspect or ground slope. On average, equatorial areas receive approximately 2.4 times as much insolation as polar areas.

instability Atmospheric condition in which displaced air tends to maintain its movement away from its original level. This occurs, for example, when rising air cools at the moist-adiabatic lapse rate while a greater environmental lapse rate allows the air parcel to remain warmer than surrounding air (or even increases the temperature difference) so that continual buoyancy prevails. *See also* conditional instability; potential instability; and stability.

instinct Genetically acquired force that impels animals to behave in certain fixed ways in response to particular stimuli. The term is little used by modern ethologists because it is open to many of the same objections as the term 'drive'; because it makes no allowance for environmental influences upon patterns of behaviour; and because behaviour that formerly was considered to be 'instinctive' is known now to result from several different categories of motivation.

instrumental conditioning *See* operant conditioning.

insulin Protein hormone secreted by the beta-cells of the islets of Langerhans in the pancreas. It stimulates the utilization of glucose by the cells and thereby lowers the blood-sugar level. A deficiency of this hormone results in the condition known as diabetes mellitus.

integrated pest control Pest control that uses both biological and chemical agents.

integument Coats of the ovule, usually two in flowering plants, which develop into the seed coat or testa after fertilization.

intensification In meteorology, the increase of pressure gradient around a pressure system. *See also* weakening.

intensity scale (ethol.) Sequence of thresholds such that progressively stronger stimuli are needed before the appropriate patterns of behaviour result.

These stimuli may be increasingly intensive repetitions of a single stimulus, e.g. a spider that is only slightly hungry does not respond to prey; when rather more hungry it turns toward the prey; when still more hungry it initiates an attack.

intention movement First stage in a recognized sequence of behaviour; by itself it indicates to an observer the intention of an animal to perform the full sequence. For example, the swimming of a stickleback low over a small area of a sandy river-bed during the breeding season may be an intention movement: it may herald the digging of a pit and the building of a nest.

intercalary meristem *See* meristem.

interclavicle In the pectoral girdle of tetrapods, but absent from mammals except for the Monotremata, a median bone on the ventral side between the clavicles.

interferon Proteins produced in very small quantities, by leucocytes and related cells, in response to viral infection. As a group they appear to induce the synthesis of a protein that interferes with a viral-specific function. This often confers a temporary resistance to subsequent infection by other viruses.

interflow *See* throughflow.

interglacial Period of warmer climate that separates two glacial periods. Mid-latitude interglacials show a characteristic sequence of vegetation change. Pollen of heathy tundra is replaced in the pollen record by abundant herbaceous pollen, which in turn is replaced by that of boreal and subsequently deciduous forest, including pollen of thermophilous species, e.g. *Tilia* (lime). From this peak the sequence reverses as the trend to colder conditions predominates. The timespan of interglacials varies, but is of the order of 10 000–12 000 years.

intergrade Soil or soil horizon that has the properties of two genetically different soils or horizons. An intergrade can be regarded as transitional between two distinctive soils or horizons.

intermediate filament Filament or fibre, approximately 10 nm in diameter, that contributes to the cytoskeletal structure of eukaryotic cells. There are several types, each composed of a different non-motile structural protein such as keratin, vimentin, or desmin.

intermediate rock Igneous rock whose chemical composition lies between those of basic and acidic rocks. The limits are not fixed rigidly and a number of schemes exist that are based on modal mineralogy and the whole rock chemistry.

interna *See Sacculina carcini*.

internal wave Wave that forms within a water mass at the boundary of two water layers that have different densities. The boundary may be abrupt or gradual, and the slow-moving waves can be detected only by instrumental observations of temperature or salinity, and by acoustic scattering.

International Biological Programme (IBP) An international research programme conducted approximately from 1966 to 1975 with the aim of understanding the dynamics of whole ecosystems from a range of world environments, e.g. desert, and tropical rain forest. Objectives included the development of predictive mathematical models for ecosystem structure and function to help assess the effects of as yet unexperienced environmental impacts, as well as aiding the understanding of changes associated with past disruptions. Although not all the projects were equally successful and a complete reference set of models has not been produced and accepted, the models that do exist provide a rational basis for evaluating the likely consequences of proposed human interventions, for remedying the effects of previous human use of an area, and for adapting management systems to improve productivity and environmental quality.

International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, ICZN) **1** The regulations governing the scientific naming of animals. **2** The international authority that draws up those regulations and that supervises their application.

International Union for Conservation of Nature and Natural Resources (IUCN) An international, independent organization, founded in 1948, with headquarters at Morges, Switzerland, that promotes and initiates scientifically-based conservation measures. Its members include more than 450 government agencies and conservation organizations in more than 100 countries, and it works closely with United Nations agencies. It publishes data books listing endangered species, and in 1980 it published the *World Conservation Strategy* in collaboration with the UN Environment Programme, the World Wildlife Fund, the Food and Agriculture Organization, and UNESCO.

interparietal In the posterior part of the roof of the braincase of some mammals, a small bone lying between the parietals.

interphase The resting phase of the nucleus between succeeding mitoses.

intersegmental membrane *See* arthrodial membrane.

intersex Class of individuals of a species with two sexes that possesses sexual characteristics that are intermediate. It may occur through the failure of the sex-determining mechanism of the genes (e.g. the rare occurrence of imbalance in the number of X-chromosomes—two—and the number of autosomes—three—in *Drosophila*); or through hormonal or other influences during development (e.g. the condition in cattle called free-martin, in which the female member of a pair of oppositely sexed twins has been influenced, probably hormonally, by her twin brother, through the fusing of their placental circulations).

interstadial Phase of warmer climate within a glacial period, but of shorter duration—and thought to be less warm—than an interglacial. Warmth-demanding species, e.g. *Tilia* (lime), are

not represented in the pollen record, which shows boreal affinities. The absence of thermophilous species may, however, be as much a consequence of the shorter timespan of an interstadial as of the lack of warmth.

intertidal zone Area between mean high-water level and mean low-water level in the coastal region. *See* littoral zone.

intertropical confluence Alternative term for the intertropical convergence zone (ITCZ), preferred by some purists because of the discontinuous occurrence of convergence within it.

intertropical convergence zone (ITCZ, equatorial trough) Low-latitude zone of convergence between air masses coming from either hemisphere at the boundary between north-easterly and south-easterly trade winds. Low-latitude depressions often form along the zone, which moves latitudinally with the seasons, their occurrence being mainly in the ocean sectors and sometimes leading to tropical hurricanes (or typhoons) when the zone is displaced relatively far from the equator. Over land, continental wind systems, e.g. the south-westerly monsoon and the hot, dry, desert winds in Africa, converge at the zone.

intertropical front Meeting-point of air brought by the trade winds from the circulation of winds of the northern and southern hemispheres. It is not always a sharp front, but is always a convergence zone. The equatorial rains are associated with this convergence.

intervallum The space between the inner and outer walls of Archaeocyatha.

intortus From the Latin *intortus* meaning 'twisted', a variety of cirrus cloud with irregular and intertwined filaments. *See also* cloud classification.

intraformational *See* conglomerate.

intrinsic rate of natural increase *See* biotic potential.

introgression Incorporation of genes of one species into the gene pool of another. If the ranges of two species overlap and fertile hybrids are produced, the hybrids tend to backcross with the more abundant species. This results in a population in which most individuals resemble the more abundant parents but also possess some of the characters of the other parent species.

intromittent organ *See* aedeagus.

intrusion Body of rock, usually igneous, that is emplaced within pre-existing rocks. Intrusions are classified according to their size, their shape, and their geometrical relationship to the enclosing rocks.

Intsia (family Leguminosae, subfamily Caesalpinoideae) Genus of trees, which have pinnate leaves, consisting of a few big leaflets. The flowers are showy, with four sepals and one petal. The pod is big, woody, and flat, with several seeds. The trees yield valuable, hard, heavy timber (merbau). There are six or seven species, occurring in Madagascar, and from Malesia to Australia and the Pacific islands.

inulin Polysaccharide in which about 32 beta-fructose units are joined in a chain by glycosidic linkages between the first and second carbon atoms on neighbouring sugar units. Each chain is initiated by a sucrose residue. Inulin is found as a storage compound, especially in the roots, rhizomes, and tubers of many members of the family Compositae.

inverse analysis The grouping of attributes based on an analysis of the individuals that possess or lack those attributes, e.g. in plant ecology the grouping of species according to their presence, absence, or relative abundances at different sample sites. The term is used particularly in numerical vegetation classification, and is sometimes referred to as a species classification. Ordination methods may similarly be described as either plot (individual) or species (attribute) ordinations. In plant ecology especially, inverse classifications are often used to complement normal analysis. Thus data will be analysed using both approaches and coincidence between the final groups examined. It is assumed that high coincidence implies the recognition of an important 'type' community or 'nodum'. In its concept, nodal analysis is a method based on these principles. *See also* Q-technique; *compare* normal analysis; and R-technique.

inversion 1 Change in the arrangement of genetic material, involving the excision of a chromosomal segment that is then turned through 180° and reinserted at the same position in the chromosome. The result is a reversal in the order of genes in that segment of chromosome. 2 *See* temperature inversion.

invertase *See* sucrase.

inverted relief Inverse relationship between a land-form and the underlying geological structure, as when a hill is developed in a syncline and a valley in an anticline. It is a stage beyond 'normal' or Jura-type relief, which is characterized by anticlinal hills and synclinal valleys. The term also denotes the more general case in which, through erosion, a hill becomes a valley or vice versa.

in vitro Literally 'in glass', but applied more generally to studies on living material that are performed outside the living organism from which the material is derived. Examples include the use of a perfused organ, tissue cultures, cell homogenates, subcellular fractions, etc.

in vivo Applied to studies on whole, living organisms, on intact organ systems therein, or on populations of micro-organisms.

involucre Whorl of bracts below an inflorescence.

involute Having edges that roll under or inwards. Applied, for example, to coiled cephalopods in which the final whorl envelops earlier ones. *See also* vernation.

involution Contorted bedding in the near-surface zone of unconsolidated earth material or bedrock. Deformation may be regular, producing festoon-like features (e.g. 'frost boils'), or highly irregular, showing pronounced distortion and twisting. Involution is characteristic of past and present

periglacial zones, and is due basically to ground freezing.

ion Atom that has acquired an electric charge by the loss (cation; positive charge) or gain (anion; negative charge) of one or more electrons.

-ion *See* Zurich–Montpellier phytosociological school.

ionic bond Bond formed when an electron is transferred from one atom to another. The atom that loses the electron becomes a positively charged ion and the atom that gains the electron becomes a negatively charged ion. A strong electrostatic force then bonds the two ions together. The bonding in a sodium-chloride crystal (NaCl) is ionic, the crystal lattice containing Na^+ ions and Cl^- ions.

ionophorous antibiotic Generic term for a group of non-polar, lipid-soluble antibiotics. They function by facilitating the passage of alkali-metal cations (e.g. potassium) through biological membranes, thus disrupting transmembrane potentials in bacteria.

ionosphere The part of the atmosphere that lies above about 80 km altitude, with the highest concentrations of ions and free electrons. The most intense concentration is at 100–300 km altitude. Long-distance radio communications use waves that are reflected by certain regions of the ionosphere having particular concentrations of ions and free electrons. This allows radio waves to be transmitted around the curved surface of the Earth. Communications satellites make it easier to transmit higher-frequency waves (e.g. television transmissions) around the Earth, but reflection from the ionosphere continues to be used for radio transmissions, being cheaper.

ioras *See* Irenidae.

Ipnopidae (class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of deep-sea fish with a very slender body, flat head with protruding lower jaw, and peculiar yellow eyespots directed dorsally. There are about five species, distributed worldwide. *Ipnops murrayi* (15 cm) is found at depths of 1000–2000 m.

ipoh (upas tree, *Antiaris toxicaria*) *See Antiaris*.

Ipomoea (family Convolvulaceae) Genus, chiefly of climbing herbs, with showy flowers which are sometimes nocturnal. It includes *I. batatas* (sweet potato), which has sweetish, edible tubers. There are 500 species, occurring in tropical and warm-temperate regions.

Irenidae (leafbirds, ioras, fairy-bluebirds; order Passeriformes) Family of bright green, green and black, white, or blue and black birds, which have fairly long, slightly curved bills; short to medium, rounded wings; and short to long tails. They are arboreal, and found in forests. They feed on fruit, berries, and insects, and nest in trees. There are three genera, with 14 species, found in S. Asia and Indonesia.

Iré rubber *See Funtumia*.

Irian division Term coined by Schodde and Calaby (1972) to specify the lowland and hill component of the New Guinea biota, and including the rain forests of the Cape York Peninsula, Australia, nearly all of whose animals are identical at the species level with those of the lower-altitude forests of New Guinea. *See also* Tumbunan division.

Iriartea (family Palmae) Genus of palms in which the trunk is tall, surmounting a mass of stout, spiny, stilt roots. The leaves are pinnate, the leaflets premorse. The trees are monoecious. There are seven species, found in the rain forests of tropical America.

Iridaceae Family of monocotyledonous perennial herbs, growing from bulbs, corms, or rhizomes. The flowers have perianths with two similar or dissimilar whorls, each of three segments, three stamens, and an inferior, three-celled ovary. They are cosmopolitan, with some 70 genera, comprising 1800 species. Many genera are cultivated, especially *Iris*, *Crocus*, and *Gladiolus*.

iridescence Physical phenomenon in which fine colours are produced on a surface by the interference of light that is reflected from both the front and back of a thin film.

iridescent clouds High clouds, usually observed within 30° of the Sun, with red, green, yellow, blue, or violet tints along their edges. Tiny cloud particles cause diffraction of light rays, producing the coloured effect.

iridoviruses (Iridoviridae) Group (family) of viruses in which the virions are large, icosahedral, and contain double-stranded DNA. Iridoviruses infect chiefly insects of the Coleoptera, Diptera, and Lepidoptera, causing diseases which are often fatal.

Iris (family Iridaceae) Genus of Iridaceae, with rhizomes or bulbs; leafy shoots usually flattened in one plane; and showy, characteristic flowers, the three outer perianth segments (the 'falls') of which usually arch down and are larger than the three inner perianth segments (the 'standards'), which are often more or less erect and stalked. The three style-branches are broad and petal-like, and forked at the apex. There are some 300 species, throughout the northern temperate zone, many being cultivated (as are many hybrids) for their beautiful flowers.

Irish elk *See* allometry; and Cervidae.

Irish moss Common name for the red seaweed *Chondrus crispus*, formerly widely used in folk medicine and now used commercially as a source of carrageenan. *See also* carragheen.

iroko (*Chlorophora excelsa*) *See Chlorophora*.

iron (Fe) Element required by plants. It is used in reactions in which rapid oxidation–reductions occur by the transfer of electrons, as in photophosphorylation and oxidative phosphorylation. Other roles are not understood. Iron-deficient plants have chlorotic young leaves: at first the veins remain green but later they too become chlorotic.

iron bark Group of *Eucalyptus* species, named from their distinctive bark.

iron glance *See* haematite.

iron pan Indurated soil horizon, found usually at the top of the B horizon, in which iron oxide is the main cementing material.

ironstone *See* plinthite.

ironwood (*Mesua ferrea*) *See Mesua*.

irradiance Intensity of radiation. The amount of light energy falling per unit area per unit time.

irregular (of plants) *See* zygomorphic.

irrelevant behaviour Activity that interrupts a pattern of behaviour temporarily and that does not contribute to the function of that pattern.

irruption Sudden change or oscillation in the population density of an organism.

Irvingia (family Simaroubaceae) Genus of trees in which the leaves are simple, with stipules fused as a cap over the apical bud. The fruit is a drupe. There are three species, occurring in the African and Asian tropics.

ischial callosity Area of hard or thickened skin on the buttocks.

ischium In tetrapods, the part of the pelvis that projects backward on the ventral side. In Primates, it bears the weight of the sitting animal.

Ischnocera (class Insecta, order Phthiraptera) Suborder of chewing lice characterized by the pulvinus (a spongy pad between the front of the head and the mouth) and the vertical articulation of the mandibles. The suborder contains two families that are parasitic on placental mammals, and three that are parasitic on birds. Their food includes feathers, skin, sebaceous exudates, and blood; and some species are known to eat other lice, although these are probably not an important part of their diet. There are 120 genera, with about 1800 species.

Ischnochitonina (class Amphineura, subclass Polyplacophora, order Neoloricata) Suborder of molluscs whose members vary considerably in size. Every valve has insertion plates, and the valves are morphologically divided into three areas. The width of the girdle is extremely variable. They first appeared in the Triassic.

Ischyrinioida (phylum Mollusca, class Rostroconchia) Order of rostroconchs in which the protoconch is in a posterior position on the shell. A radial ornament of fine ribs covers the shell, which is generally oval in shape. The order ranges in age from Lower to Upper Ordovician.

Ischyromyidae (order Rodentia, suborder Sciuromorpha) Extinct family comprising the most ancient ancestors of rodents, which lived from the late Palaeocene to the Middle Eocene, probably as scampering, squirrel-like animals. The skull and teeth retain many primitive features. There are more teeth than in later rodents, but the front upper premolar is reduced and lost in some species. The jaw lacks modifications found in later rodents.

Isectolophidae One of several Eocene families of ceratomorph perissodactyls, a group represented today by the tapirs and rhinoceroses.

isidium Small branched or unbranched growth that develops from the thallus in certain lichens. Isidia may function as propagules.

isinglass Gelatinous substance obtained from the inner lining of the swim-bladder of certain fish (e.g. sturgeon, catfish, and carp). It is prepared for industrial purposes and was once used domestically to preserve eggs.

island arc Series of volcanoes that lies on the continental side of an oceanic trench of a lithospheric plate. The volcanism, mainly of intermediate composition, results from the subduction process; typically it occurs approximately 100 km above the down-going oceanic plate. Island arcs are the sites of strong seismic activity, and have distinctive thermal and magnetic properties.

island biogeography Islands are numerous and their biotas are often small enough to be quantified. Accordingly it has been possible to determine a relationship between area and species number, as an equilibrium between immigration and extinction. This is the basis of island biogeography; and it also has great relevance to the continents, where plant and animal communities are effectively reduced to islands in a sea of cultivation or urbanization.

island biotas The plants and animals of oceanic islands. Because of their isolation, the biotas normally include numerous endemic taxa. Island biotas are generally fragile, unbalanced in that they lack plants and animals with poor trans-oceanic dispersal capacities, and vulnerable to disturbance by man and introduced species.

island hopping Colonization of an island or islands by plants and animals from an adjacent island or islands. Birds are particularly likely to island-hop. Over geological time, islands drift away from their areas of origin. The descendent biotas maintain themselves in the ancestral environment by island hopping on to successively younger islands as these emerge.

islets of Langerhans *See* insulin.

isobar Line on a weather map connecting points at the same atmospheric pressure. On surface charts the values are 'reduced' to sea-level. Such isolines are drawn at a given interval in millibars. Contours of isobaric surfaces may be drawn to represent surfaces in the upper atmosphere composed of points at the same pressure.

isobaric surface A surface on which any point experiences the same atmospheric pressure. *See also* isobar.

Isobryales (subclass Bryidae) Order of pleurocarpous mosses in which the primary stems are prostrate and creeping but the secondary stems may be erect; branching is irregular to pinnate or dendroid. The leaves are usually ovoid to lanceolate, may be nerved or not, and have pointed tips. Capsules are round to cylindrical; the peristome is double. Genera include *Climacium*, *Fontinalis* and *Neckera*. They are found in a variety of habitats.

isocercal tail In fish, a tail in which there is an apparent symmetry between the dorsal and ventral regions, the fin rays being supported by equal-sized arches of the penultimate vertebrae as well as by the reduced, plate-like, ultimate vertebra. It is found, for example, in cod.

isoclinal fold In geology, a fold in which the two limbs are parallel.

Isocrinida (sea-lilies; class Crinoidea, subclass Articulata) Order of sea-lilies, which possess a long stem, characteristically five-lobed in cross-section, which bears whorls of cirri at irregular intervals along its length. The small cup is dicyclic, with concealed infrabasals. The arms are generally branched several times. The order is known from the Triassic to Recent.

isoelectric focusing Technique for the electrophoretic separation of amphoteric molecules in a gradient of pH, usually formed from a combination of buffers held on a polyacrylamide-gel support medium. The molecules will move in the gradient, under the influence of an electric field, until they reach their isoelectric pH (i.e. the pH at which they are electrically neutral), where they form a sharp band. Separation is achieved because the various molecular species will have different isoelectric pHs.

isoenzyme (isozyme) Species of enzyme that exists in two or more structural forms which are easily identified by electrophoretic methods.

Isoetaceae Family of Pteridophyta, mostly aquatic vascular cryptogams with two types of spores (*see* heterospory). They have a short, stout, basal stock from which arise the roots below; and a dense rosette of usually tubular, quill-like leaves, which bear the sporangia sunken in their expanded bases. Megasporangia are produced in the bases of the first leaves of the season; these contain large megaspores which develop into female gametophytes. Microsporangia are produced in later leaves; these contain tiny microspores which develop into minute male gametophytes. There are two genera: *Isoetes*, with some 70 species of cosmopolitan distribution, and *Stylites*, with one species in the Peruvian Andes.

Isoetes *See* Isoetaceae.

isofrigid *See* pergelic.

isogamy Fusion of gametes that are morphologically alike. This is an uncommon condition, found in some green algae, fungi, and Protozoa.

isogeneic (syngeneic) Applied to a graft involving a donor and a host that are genetically identical.

isohel Line, drawn on a map, connecting points of equal average sunshine duration.

isohyet Line, drawn on a climate map, connecting points of equal average rainfall.

isohyperthermic *See* pergelic.

isokont Having flagella of equal length.

isomer Either or any of two or more compounds that have the same molecular composition but different molecular structure. Isomers differ from each other in their physical and chemical properties.

isomerase Enzyme that catalyses a reaction involving the interconversion of isomers.

isomesic *See* pergelic.

isomyarian Applied to the condition in certain pelecypods in which the two adductor muscles are of approximately the same size.

isoneph Line, drawn on a map, joining points of uniform cloud cover.

Isonidae (class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of marine fish closely related to the silversides (Atherinidae). Often found close to the surf zone, *Iso hawaiiensis* is a small (10 cm) fish with large eyes, a small mouth, and a small first dorsal and small pelvic fins; it is typical of the family. About six species are found, in the Indo-Pacific region.

isonome *See* transect.

Isopoda (pill bugs, slaters, woodlice; class Crustacea, subclass Malacostraca, superorder Pericarida) Large, diverse order of crustaceans, from 5–15 mm long, forming a specialized subdivision of their superorder. Isopods occupy many habitats, from the deep sea to true terrestrial niches. Some are even parasitic. They are almost always dorsoventrally flattened and adapted for crawling, and lack a carapace. The largest body division (the pereon) is made of up to seven somites, each bearing one pair of uniramous walking legs. The leathery, flexible exoskeleton may have brown or grey markings, and some species possess specialized cells (chromatophores) which to some degree enable the animal to match its colour to the substratum. The head bears unstalked, compound eyes, and uniramous first antennae with sensory setae. Most isopods are scavengers and omnivores, with compact mouthparts and a well-developed cardiac (or triturating) stomach. The pleopods, unlike those of most other Crustacea, have become developed for gaseous exchange. Burrowing is common in marine forms and some species can damage docks and wooden piling (e.g. *Sphaeroma* and the gribble, *Limnoria*). Characters such as internal fertilization, a marsupium (or brood pouch), and walking legs are pre-adaptations for the successful life-style of the terrestrial forms. There are 4000 known species, most of them marine.

isoprene (2-methyl butadiene) Five-carbon compound that forms the structural basis of many biologically important compounds, e.g. the terpenes.

isoprenoid Compound comprising two or more isoprenes or their derivatives.

Isoptera (termites, white ants; class Insecta) Order of hemimetabolous insects, related to cockroaches, in which all species are social and polymorphic, with primary and secondary reproductives, soldiers, and workers. Nests (termitaria) may be cavities in the ground or wood, earth mounds, or carton constructions. Termites forage for plant

material, using odour trails, and rely on gut-swelling, symbiotic micro-organisms (protozoa in lower termites, bacteria in Termitidae) for the digestion of cellulose. Anal trophyllaxis distributes these symbionts, and pheromones involved in caste determination, among the colony members. There are about 2200 living species, most being restricted to the tropics.

Isospondyli Older name for a group of herring-like (soft-rayed) fish which comprise the four super-orders: Elopomorpha, Osteoglossomorpha, Clupeomorpha, and Ostariophysi.

isostasy Concept that the large masses of the Earth tend to a floating equilibrium and that changes in the mass of one block will be compensated for by the uplifting or sinking of other blocks.

isotherm Line, drawn on a climate map, connecting points of equal average temperature.

isothermic *See* pergelic.

isotope One of two or more varieties of a chemical element whose atoms have the same numbers of protons and electrons but different numbers of neutrons. There are 300 naturally occurring isotopes, but only 92 naturally occurring elements. Isotopes may be produced by various nuclear reactions. Frequently the products are radioactive. *See also* isotopic dating.

isotopic dating Means of determining the age of certain materials by reference to the relative abundances of the parent isotope (which is radioactive) and the daughter isotope (which may or may not be radioactive). If the decay constant (the 'half-life' or disintegration rate of the parent isotope) and the concentration of the daughter isotope are known, it is possible to calculate an age. *See also* dating methods: radioactive decay; radiocarbon dating; and radiometric dating.

isozyme *See* isoenzyme.

Istiophoridae (marlin, sailfish, spearfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have strongly streamlined bodies. They are distinguished easily by the long bill (upper jaw) and the high dorsal fin, which is even more accentuated in the sailfish. When swimming, the long-based dorsal fin is folded down into a special groove at the back. The deeply forked tail-fin has very long dorsal and ventral lobes. The marlins, sailfish, and spearfish are highly regarded by game fishers because of their fighting capacity, speed and size. *Makaira nigricans* (blue marlin) can grow to about 5 m; *Istiophorus platypterus* (sailfish) grows to about 2.5 m. There are about 10 species, distributed worldwide in tropical to subtropical seas.

Istiophorus platypterus (sailfish) *See* Istiophoridae.

istle fibre *See Agave*.

Isurus oxyrinchus (mako shark) *See* Lamnidae.

Italian wall lizard *See Podarcis sicula*.

ITCZ *See* intertropical convergence zone.

iterative evolution Repeated evolution of similar or parallel structures in the development of the same main line. There are many examples of iterative evolution in the fossil record, spanning a wide range of groups. This evolutionary conservatism is probably due to the overriding morphogenetic control exerted by certain regulatory genes.

IUCN *See* International Union for Conservation of Nature and Natural Resources.

ivory nut (*Phytelephas macrocarpa*) *See Phytelephas*.

ivy *See Hedera*.

iwatake The lichen *Umbilicaria esculenta*, which is edible and considered a delicacy in Japan.

Ixora (family Rubiaceae) Genus of shrubs and small trees in which the flowers are showy with a long tube, and borne in heads. Several species are ornamentals. There are 400 species, with a pantropical distribution.

J

Jacamaralcyon tridactyla (three-toed jacamar) *See* Galbulidae.

jacamars *See Brachygalba*; Galbulidae; and Piciformes.

jacanas *See* Jacanidae.

Jacanidae (jacanas; order Charadriiformes) Family of rufous, greenish-brown, and black birds which have a medium-length bill, and broad wings. Their legs are long, with bare tibiae and extremely long toes and claws. They inhabit the marshy shores of lakes and streams, walk on surface vegetation, feed on insects, aquatic animals, and vegetation, and nest on floating plants. There are six genera, with eight species, found in C. and S. America, Africa, S. Asia, and Australasia.

Jacaranda (family Bignoniaceae) Genus of trees in which the leaves are bipinnate, and opposite. The flowers are bluish-lilac in colour, and borne in panicles or clusters. The fruit is a short pod. *J. filicifolia* is a widely-grown ornamental. There are 300 species, occuring in tropical America.

jack *See* Carangidae.

jackal (*Canis*) *See* Canidae.

jackass morwong (*Nemadactylus macropterus*) *See* Cheilodactylidae.

jackfruit (jak, *Artocarpus integrifolia*) *See Artocarpus*.

Jacksonia (family Leguminosae, subfamily Papilionoideae) Genus of plants, most of which are shrubs with simple or palmate leaves. They are adapted to arid conditions, but a few species occur in the rain forests of central Australia. There are 46 species, all of them endemic to Australia, and mainly confined to the west.

Jacob's ladder *See* crepuscular rays.

jaguar (*Panthera onca*) *See Panthera*.

jak (jackfruit, *Artocarpus integrifolia*) *See Artocarpus*.

Jamoytius *See* Agnatha.

Japanese giant salamander *See Andrias japonicus*.

Japanese island crab *See Macrocheira kaempferi*.

Japanese silver bream (*Acanthopagrus latus*) *See* Sparidae.

Japanese umbrella pine *See Sciadopitys*.

japonica *See Chaenomeles*.

japweed Common name for the seaweed *Sargassum muticum*; the seaweed originated in Japan but recently has become established on the coasts of Europe and N. America. It is regarded as a pest, fouling boat propellers and fishing nets and disturbing the natural balance of the indigenous marine flora and fauna.

Japygidae *See* Diplura.

jarrah (*Eucalyptus marginata*) *See Eucalyptus*.

jarrah die-back Disease of jarrah (*Eucalyptus marginata*, the mahogany gum-tree) caused by the fungus *Phytophthora cinnamoni*. The disease is of considerable economic importance in Australia, where *E. marginata* is an important timber tree.

Jasus huegeli (giant spiny lobster; order Decapoda, family Palinuridae) Species of large, edible decapod which attains a length of up to 60 cm. It occurs in southern temperate waters.

Jatropha (family Euphorbiaceae) Genus of shrubs, a few of which are xerophytes with swollen stems. Male and female flowers are borne in the same panicle. The fruit is a three-shouldered, leathery, indehiscent capsule. There are 175 species, occurring in the tropics and subtropics, and in N. America and S. Africa.

javelinfish *See* Pomadasyidae.

jawfish *See* Opisthognathidae.

jawless fish *See* Agnatha.

jays *See* Corvidae; and *Garrulus*.

jellyfish *See* Scyphozoa.

jelly fungus Common name for any fungus of the Phragmobasidiomycetidae in which gelatinous fruit bodies are formed.

jelutong *See Dyera*; and Sapotaceae.

Jenynsiidae (class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of freshwater fish, of interest mainly because both males and females have the sex organs directed either to the left or to the right. A 'left' male can mate only with a 'right' female, and vice versa. There are about three species, none exceeding 12 cm in length, found in southern S. America.

jerboa *See* Dipodidae.

jerboa-rat (*Notomys*) *See* Muridae.

Jerusalem artichoke (*Helianthus tuberosus*) *See* Compositae.

Jerusalem crickets *See* Stenolpelmatidae.

jet stream Concentrated, high-speed air flow, generally in a broadly westerly (i.e. west to east) direction. The principal global jets are the polar front and the subtropical jets, at heights respectively of about 10–12 and 12–15 km, and the polar-night or winter jet stream in the upper stratosphere or mesosphere at about 50–80 km. The intensity of the jets in narrow bands (the maximum velocity is commonly about 50–100 m/s, but greater speeds are sometimes observed) results from a large poleward increase in pressure gradient with altitude. This is a product of the pole–equator

temperature gradient in the air beneath the jet. As pressure decreases more rapidly with height the lower the temperature, so pressure in the colder, polar air masses decreases more rapidly with height than over the regions with warmer air masses. Above the jet, wind speed diminishes as the pressure gradient declines with increasing height, owing to the effects of a different heating pattern in the stratosphere. *See also* polar jet stream; and subtropical jet stream.

jewel beetle *See* Buprestidae.

jewel wasps *See* Pteromalidae.

jewfish (*Glaucosoma hebraicum*) *See* Glaucosomidae.

jew lizard *See Amphibolurus barbatus*.

jew's ear Common name for the ear-shaped fruit bodies of *Auricularia auricula* (*Hirneola auricula-judae*).

jezebels *See* Pieridae.

Job's tears (*Coix lachryma*) *See Coix*.

Johannesteijsmannia (family Palmae) Genus of palms, most of which are stemless, solitary palms, with huge, spectacular, diamond-shaped or lanceolate, undivided leaves, up to 2.5 m long, with essentially palmate nervation. The inflorescences are among the leaves. The flowers are small, scented, and hermaphrodite, with three free carpels. The fruits have a thick, knobbly wall. There are four species, occurring in lowland rain forests in Malaya (where three of the species are found), Sumatra, and Borneo.

John Dory (*Zeus faber*) *See* Zeidae.

joint 1 Fracture in a rock resulting from shrinkage, due to cooling or desiccation, or to the unloading of superincumbent rocks by erosion or tectonism. 2 (columnar joint) Joint that splits a rock into long prisms or columns. It is most commonly found in tabular bodies of igneous rocks.

jointed nine-awn (*Enneapogon cylindricus*) *See Enneapogon*.

Joinvillea (family Flagellariaceae) Genus of giant grass-like herbs which have plicate leaves with a sheathing base. The flowers are bisexual, petaloid, and borne in panicles. There are three species, occurring from Malesia to the Pacific islands.

jökulhlaup Sudden, violent, but short-lived increase in the discharge of a meltwater stream issuing from a glacier. Typically it is due to the rapid drainage of an ice-dammed lake, e.g. L. Grimsvotn on Vatnajökull, Iceland. Flow velocity may reach 7–8 m/s and the discharge may attain 100 000 m^3/s (e.g. the Katlahlaups from Myrdalsjökull, Iceland).

jollytail *See* Galaxiidae.

jongkong *See Dactylocladus*.

jorales *See* Mediterranean scrub.

Jordanella floridae (American flagfish) *See* Cyprinodontidae.

J-shaped growth curve Curve on a graph that records the situation in which, in a new environment, the population density of an organism increases rapidly in an exponential or logarithmic form, but then stops abruptly as environmental resistance (e.g. seasonality) or some other factor (e.g. the end of the breeding phase) suddenly becomes effective. It may be summarized mathematically as: $dN/dT = r$ (with a definite limit on N) where N is the number of individuals in the population, T is time, and r is a constant representing the intrinsic rate of increase (biotic potential) of the organism concerned. Population numbers typically show great fluctuation, giving the characteristic 'boom and bust' cycles of some insects, or as seen in algal blooms. This type of population growth is termed 'density-independent' as the regulation of growth rate is not tied to the population density until the final crash. *Compare* S-shaped growth curve.

Juan Fernandez floral region Part of Good's (1974) Neotropical kingdom, which corresponds geographically to the islands of Juan Fernandez and the Desventuradas Islands, 650–1000 km off the coast of Chile. There is a remarkable degree of endemism, including one family, 18 genera, and nearly 160 species.

Jubaea (family Palmae) Monospecific genus, comprising *J. spectabilis*, the Chilean wine palm, which is the southernmost of all palms. Very hardy, it has probably the stoutest of palm trunks, 1.2–1.8 m diameter. The leaves are pinnate, their bases persistent. It is monoecious. The tree is felled for its sugary sap which makes a honey or wine, and it is now rare.

Judas tree *See Cercis*.

jugal Bone on the side of the face, beneath the eye.

Juglandaceae Family of trees, in which the leaves are pinnate, with no stipules. The flowers are small, unisexual, and bracteate, and borne in spikes or catkins; they are wind-pollinated, and have an inferior ovary. The fruit is a drupe or nut, sometimes attached to a wing-like bract. The family yields several useful timbers (e.g. walnut and hickory) and fruits (e.g. walnut and pecan). There are six genera, with 60 species, most of which occur in northern temperate regions, but a few of which are tropical.

Juglans (walnut; family Juglandaceae) Genus of deciduous, nut-bearing trees, up to 30 m tall, with twisting, spreading branches. They have large, oily, deeply-lobed cotyledons. The leaves are compound. Male and female catkins occur on the same tree, the male catkins dangling in the wind, the female catkins upright. They produce oval, green fruits (a drupe) with a fleshy exocarp and a bony endocarp (the shell), which splits down the midrib. The wrinkled, woody nut is eaten fresh or pickled, and used in desserts, cakes, and confectionery. The most popular garden species are *J. regia* (Persian walnut), *J. nigra* (black walnut), and *J. cinerea* of N. America, the butternut. The wood is used for furniture. There are about 15 species, occurring mainly in northern temperate regions, but extending to the tropics and native to Asia and America.

jugum *See* Hepialidae.

jujube (*Zizyphus jujuba*) *See Zizyphus*.

jumping mouse *See* Zapodidae.

jumping spiders *See* Salticidae.

Juncaceae Family of monocotyledonous herbs. They are close to Liliaceae in the structure of the trimerous flowers, but these are small and inconspicuous, with tiny, chaffy perianth-segments, and adapted to wind pollination. The leaves are long and narrow, and either grass-like or nearly cylindrical in form. They are of little economic value but are important ecologically, especially in poorly drained areas. There are eight genera, with some 350 species, of cosmopolitan distribution, but centred in temperate zones.

Juncaginaceae Family of monocotyledonous herbs, with mostly linear, radical, sheathing leaves, and erect spikes or racemes of tiny di- or trimerous flowers without bracts. The ovary is superior, with four or six carpels, usually joined together, and a short style. *Triglochin* (arrow-grass) is widespread and occurs in wet places. There are three genera, with 14 species, distributed in temperate and cold, marshy habitats in the northern and southern hemispheres.

Juncus (rush; family Juncaceae) Genus of tufted, usually perennial herbs with entire leaves and open leaf sheaths. The inflorescence is small, with bisexual, usually brown flowers; it produces capsules and many seeds. There are well over 300 species. Distribution is cosmopolitan, but the plants are mainly restricted to cold and wet places, and are therefore rare in the tropics.

June berries *See Amelanchier*.

Jungermanniales (class Hepaticae) Order containing the leafy liverworts. The shoots are usually prostrate or ascending and have a dorsiventral organization. The leaves commonly overlap one another in one of two ways: in the 'succubous' arrangement the upper edge of each leaf (i.e. that nearest the shoot apex) is hidden beneath the lower edge of the leaf above; in the 'incubous' arrangement the lower edge of each leaf is hidden by the upper edge of the next leaf down. These arrangements are constant characters in genera. Genera include *Cephalozia*, *Diplophyllum*, *Frullania*, *Lophocolea*, *Nardia*, *Plagiochila*, *Pleurozia*, *Porella*, and *Scapania*.

jungle Subclimax tropical rain forest, consisting of a tangled growth of lianes, bamboo scrub, palms, etc. It forms an impenetrable barrier to travel. It is characteristic of former clearings and of riversides, where light penetration is greater than in the forest interior. By contrast, true climax rain forest has little undergrowth since light penetration is poor, and—contrary to the popular image—it is easily negotiated.

jungle babblers *See Trichastoma*.

junglefowl *See Gallus*.

Juniperus procera (East African pencil cedar) Valuable, small- to medium-sized coniferous tree, which is widespread and common in the mountains of E. Africa.

Jurassic One of the three Mesozoic periods: it lasted approximately 50 million years, following the Triassic and preceding the Cretaceous. The Jurassic is subdivided into 11 stages, with clays, calcareous sandstones, and limestones being the most common rock types. Brachiopods, bivalves, and ammonites were abundant, along with many other invertebrate stocks. Reptiles flourished on land and in the sea, but mammals were relatively insignificant and mostly nocturnal. The first birds, including *Archaeopteryx*, appeared in the Upper Jurassic.

Jura-type relief *See* inverted relief.

juvenile hormone Hormone released by the corpora allata, which regulates the form of larvae after each moult. Juvenile hormone brings about the retention of juvenile characteristics in developing insects, but has other functions in adults. *See also* corpus allatum.

Jynx (wrynecks; family Picidae) Genus of small, cryptically coloured, brown, grey, and black birds which are zygodactylous like other woodpeckers, but which rarely cling to trees. They inhabit woodland; feed on insects, especially ants; and nest in tree cavities. There are two species, found in Europe, Asia, and Africa. *J. torquilla* (common wryneck) is highly migratory.

Jynx torquilla (common wryneck) *See Jynx*.

K

K *See* potassium.

kagar *See Dryobalanops*.

kagu (*Rhynochetos jubatus*) *See* Rhynochetidae.

kainite Evaporite mineral, specific gravity 2.1, hardness 2.5–3.0, and with the chemical composition $MgSO_4.KCl.3H_2O$. It occurs widely in salt deposits and in association with halite, carnallite, etc. It is variable in colour, from white through yellow to reddish, with a vitreous lustre. It crystallizes in the monoclinic system. Crystals are rare and they usually form granular masses. Kainite is used as a fertilizer and as a source of potassium salts.

kala-azar Disease of humans, found chiefly in tropical regions; symptoms include enlargement of the spleen, with anaemia, fever, and prostration. The causal agent is a protozoon, *Leishmania donovani*, which is transmitted by sandflies (*Phlebotomus*).

Kalotermitidae (order Isoptera) Family of lower termites which form small colonies and feed in dry, dead wood. Pheromones secreted by the king and queen prevent pseudergates from metamorphosing. When the queens die this inhibition is released, and the pseudergates are transformed into reproductives. There are about 300 species, with a worldwide distribution but found mainly in the tropics.

kame Steep-sided mound composed of bedded sand and gravel which often shows signs of marginal slumping. It is a land-form of glacial deposition, associated with stagnant ice whose removal by melting causes the collapse.

kame delta Flat-topped mound of stratified sand and gravel laid down in standing water at an ice margin. Subsequent ice melt and loss of support brings about collapse at the ice-contact margin.

kame terrace Continuous valley-side land-form consisting of stratified sand and gravel whose outer edge typically shows collapse features. It is laid down by meltwater at the junction between an ice mass and the valley wall.

kampfzone Altitudinal belt of stunted and often prostrate trees, found between the upper limit of tall, erect trees growing in forest densities (waldgrenze) and the extreme upper limit of tree growth (the species limit or baumgrenze). *See also* elfin wood.

kanamycin *See Streptomyces*.

kangaroo *See* Macropodidae.

kangaroo grasses *See Themeda*.

kangaroo paw *See Angiosanthos*.

kangaroo rat *See* Heteromyidae.

kaolinite Mineral, specific gravity 2.6–2.7, hardness 2.0–2.5, and with the chemical composition $Al_2Si_2O_5(OH)_4$, whose name is derived from Chinese and means 'high ridge'. It occurs as a secondary mineral produced by the alteration of alumino-silicates, especially alkali-feldspars. It is widely distributed, and found in igneous rocks, gneisses, and pegmatites; and also in sedimentary rocks due to the action of acidic solutions on a wide variety of rocks by processes of weathering and low-temperature hydrothermal reactions. It is distinguished by its plastic feel, but normally it has to be identified by optical and physical tests. It is white, greyish, or stained a variety of colours, and it has a dull earthy lustre. It crystallizes in the monoclinic system. On a microscopic scale the crystals are hexagonal plates, but it is usually massive. The mineral is extensively used when pure, as a cheap, general-purpose filler and coating material for paper, in ceramics, and also in chemicals and paints. It is an aluminosilicate mineral (clay mineral) of the 1 : 1 crystal-lattice group and is distinctive in soils for its physical stability during wetting and drying and for its small cation-exchange capacity. Kaolinite dominates the clay minerals present in certain acid and very old soils, but not in Oxisols, some latosols, or soils formed in arid climates.

kapok (*Ceiba pentancua*) *See Ceiba*.

K–Ar method *See* potassium–argon method.

karren German term describing the group of solutional features developed at the surface of an outcrop of hard limestone. Forms range from runnels a few millimetres deep to fissures (grikes) extending several metres into the limestone.

karri (*Eucalyptus diversifolia*) *See Eucalyptus*.

karst 1 Area of the Dinaric Alps of Yugoslavia underlain by limestone. 2 Any region underlain by limestone and characterized by a set of landforms resulting largely from the action of carbonation. 3 By extension, regions in which other types of rock solution are important, e.g. thermokarst in the periglacial environment.

karyotype The entire chromosomal complement of an individual or cell, which may be observed during mitotic metaphase.

katabatic wind (drainage wind, mountain breeze) Generic term for the wind that occurs when cold, dense air, chilled by radiation cooling, usually at night, moves downslope gravitationally beneath warmer, less dense air. The occurrence is frequent and widespread in, for example, the fjords of Norway, and as an outblowing wind over ice-covered surfaces in Antarctica and Greenland, where the wind may be extremely strong near the coasts and less severe in many mountain regions.

katafront After Bergeron, a weak frontal condition in which warm-sector air sinks relative to colder air.

Katsura tree (*Cercidiphyllum japonicum*) *See* Cercidiphyllaceae.

katydid *See* Tettigoniidae.

kauri pines *See Agathis*.

kava (*Piper methysticum*) *See Piper*; and Piperaceae.

keeled belly (*Gasteropelecus sternicla*) *See* Gasteropelecidae.

kelp Brown seaweeds that grow below the low-tide level. Large brown algae, e.g. *Laminaria* species, which anchor themselves firmly to the sea-bed are typical. Kelp accumulations are important sources of iodine and potash.

kelpfish *See* Chironemidae.

kelp flies *See* Coelopidae.

kelp greenling (*Hexagrammos decagrammus*) *See* Hexagrammidae.

kempas (*Koompassia malaccensis*) *See Koompassia*.

kennarten species (characteristic species) Like 'faithful species', a former collective term for species of fidelity classes 3–5 (i.e. preferential, selective, and exclusive species). As phytosociological work progressed, the need became evident for finer distinction within the kennarten species. *See also* faithful species.

kentallenite Variety of olivine-bearing monzonite or syenogabbro. The associated major minerals are augite, plagioclase, orthoclase, and biotite.

kentron *See Sacculina carcini*.

keranga (heath forest) Forest-heath vegetation found in SE Asia, the Amazon basin, and Guyana, and on a small area of the coast of Gabon, central Africa. It grows on siliceous, podzolic soils. Much of the nutrient supply for this dense vegetation is furnished by rainfall rather than by rock-weathering.

keratin Group of fibrous schleroproteins that usually contain large amounts of sulphur as cystine and which form the structural bases of hair, wool, nails, and other epidermal structures in animals.

keruing *See Dipterocarpus*.

Keteleeria (family Pinaceae, tribe Abietineae) Genus of conifers, with spine-tipped leaves. It is close to *Abies*, but with erect persistent cones, ovoid buds with scales forming an overlapping sheath, and male flowers in short clusters. There are some six species, native to the mountains of China.

ketone Organic compound that contains a ketone group, $>C=O$.

ketose Monosaccharide or its derivative that contains a ketone group, $>C=O$.

kettle hole Depression in the surface of glacial drift (especially ablation or kettle moraine) and resulting from the melting of an included ice mass. It may be filled with water to form a small lake ('kettle lake').

kettle lake *See* kettle hole.

Kew barometer Barometer in which the scale markings are adjusted to take account of the changes of the mercury level in the cistern, so eliminating the need for adjustment of the cistern to the fiducial point as is required in the Fortin barometer.

khamsin Hot, dry, dusty wind originating in N. Africa and blowing across Egypt, usually between April and June, ahead of depressions which move eastward or north-eastward in the Mediterranean Sea or across N. Africa, with high pressure to the east. The term is also applied to very strong southerly or south-westerly winds in the Red Sea.

kidney In vertebrates, an organ that may have arisen in freshwater animals for the purpose of voiding excess water and that is concerned in modern forms with excretion and/or the retention of water.

kieselguhr *See* diatomaceous earth.

Killarney bristle-fern (*Trichomanes radicans*) *See Trichomanes*.

killer whale (*Orcinus orca*) *See* Delphinidae.

killifish (*Fundulus heteroclitus*) *See* Cyprinodontidae.

Kimmeridgian (geol.) Penultimate stage of the Jurassic, underlain by the Oxfordian and succeeded by the Portlandian.

Kimura, Motoo Noted Japanese population geneticist, who has made important contributions to evolutionary theory by his mathematical modelling of evolutionary change based on the neutral-mutation theory.

kinaesthetic Applied to sensory receptors or organs that detect movement or changes in their own position.

kinaesthetic orientation Behaviour of an animal that moves through familiar terrain in the absence of sensory information (e.g. in total darkness) by the repetition of actions remembered from past experience of the terrain.

kinase Enzyme that catalyses reactions involving the transfer of phosphates from a nucleoside triphosphate, particularly ATP, to another substrate.

kinesis Phenomenon in which a motile organism or cell changes its rate of locomotion in response to a particular stimulus. The direction of locomotion remains random and is unrelated to the direction of the stimulus. *Compare* taxis.

kinetin (6-fururylaminopurine) One of a group of hormones, termed cytokinins, that act synergistically with auxins to stimulate cell division in plants.

kinetochore Dense, plaque-like area of the centromere region of a chromatid, to which the microtubules of the spindle attach during cell division.

kinetonucleus Term formerly used to describe the parabasal body.

kinetoplast *See* Kinetoplastida.

Kinetoplastida (class Zoomastigophorea) Order of protozoa characterized by the possession of a

kinetoplast (a region rich in DNA) within the mitochondrion of the cell. They may be free-living or parasitic. Some can cause important diseases of humans and domestic animals.

kingbirds *See Tyrannus*.

King Charles's apple *See* oak apple gall.

king cobra *See Ophiophagus hannah*.

king crabs *See* Merostomata.

king crickets *See* Stenolpelmatidae.

kingfishers *See* Alcedinidae; *Ceryle*; *Ceyx*; Coraciiformes; and *Halcyon*.

King George whiting (*Sillaginoides punctatus*) *See* Sillaginidae.

kingklip (*Genypterus capensis*) *See* Ophidiidae.

kinglets (*Regulus*) *See* Regulidae.

king-of-the-salmon *See* Trachipteridae.

king palm (*Archontophoenix alexandrae*) *See Archontophoenix*.

kino *See Pterocarpus*.

Kinorhyncha (phylum Aschelminthes) Class of very small, tube-shaped, aschelminth worms in which an excretory system occurs. Most inhabit marine environments, and all adopt a benthic mode of life. There are about 100 known species.

Kinosternidae (mud and musk turtles; order Chelonia (Testudines), suborder Cryptodira) Family of freshwater turtles in which the smooth or keeled carapace may be separate from the plastron, which may be large and hinged to enclose the animal, or reduced. Some species produce evil-smelling secretions from cloacal glands. There are 20 species, occurring in the New World. *See also Sternotherus odoratus*.

kin selection Form of natural selection in which the altruism of an individual benefits its close relatives, and thereby helps to ensure the survival of at least some of its own genes. *See also* inclusive fitness.

Kirtland's warbler (*Dendroica kirtlandii*) *See Dendroica*.

kissing bug Name given to several American genera of Reduviidae that feed on the blood of mammals and birds. Some species live in and around human dwellings, where they can transmit the blood parasite *Trypanosoma cruzi*, responsible for the debilitating Chagas's disease.

kissing gourami (*Helostoma temminckii*) *See* Helostomatidae.

kites *See* Accipitridae; and *Elanus*.

Kitti's bat (*Craseonycteris thonglongyai*) *See* Craseonycteridae.

kiwi (*Apteryx*) *See* Apterygidae.

Klebsiella (family Enterobacteriaceae) Genus of Gram-negative, rod-shaped, non-motile bacteria, which occur as saprotrophs, and as parasites or pathogens of humans and other animals.

Kleinefelter's syndrome *See* Barr body.

klino-kinesis Change of direction of movement of an animal in response to a light stimulus such that the rate at which the direction changes is proportional to the strength of the stimulus.

klino-taxis Movement of an animal in response to a light stimulus: the animal compares the light intensity to either side of its body and moves either towards or away from the light, typically along a sinuous path with constant turning of the head from side to side.

klipfish (*Clinus superciliosus*) *See* Clinidae.

klippe In geology, a tectonic outlier produced by the erosion or gravity-gliding of one or more nappes. The front portions of the nappes become detached to produce the klippe structure.

knee-pieces Curved pieces of wood used in the construction of the framework of ships, and obtained mainly from the large trunks of oak standards.

Kneriidae (class Osteichthyes, subclass Actinopterygii, order Gonorynchiformes) Small family of freshwater fish which have a single dorsal fin opposite the ventral fins, a slender body, and a low-slung mouth with a protractile upper jaw. Like the other species, *Kneria auriculata* (8 cm) has accessory air-breathing facilities and can climb over land, e.g. to negotiate waterfalls. There are about 12 species, found in tropical Africa.

knick point Abrupt change of gradient in the generally smooth long-profile of a stream, and typically separating two concave-up segments. It is often attributed to a fall in base level: this, it is said, initiates a knick point which then slowly travels upstream. It may alternatively be due to a change in rock type or load size, or to tributary entry.

knife-eel *See* Gymnotidae.

knifefish *See* Notopteridae; and Rhamphichthyidae.

knifejaw (*Ostorhinchus conwaii*) *See* Oplegnathidae.

knight fish *See* Monocentridae.

knock and lochan Term descriptive of a glaciated landscape of low relief which is made up of ice-moulded hillocks and intervening lochans (small lakes) eroded along zones of rock weakness. It is especially well-developed in the Lewisian gneiss area of the coastal lowlands of NW Scotland.

knot Unit of velocity equal to one nautical mile per hour (0.515 m/s). It is still used in many countries as a measure of wind speed and current velocity.

knotted wrack *See* egg wrack.

koala (*Phascolarctus cinereus*) *See* Phalangeridae.

Kochia (family Chenopodiaceae, tribe Cyclobeae) Genus of perennial herbs found in temperate and sub-tropical areas. The plants are halophytic, with deeply penetrating roots and other xerophytic characters. The flowers are small and borne in a cymose inflorescence, usually wind-pollinated. The seed has a ring-shaped or semicircular embryo enclosing the endosperm. There are 90 species in central Europe, Asia, Africa, and Australia.

kola-nut *See Cola.*

Komodo dragon *See Varanus komodoensis.*

kona storm Storm conditions associated with very strong southerly winds over the Hawaiian Islands, bringing heavy rainfall. The winds blow in conjunction with the passage of a depression to the north of the islands.

kookaburra (*Dacelo novaeguineae*) *See* Alcedinidae.

Koompassia (family Leguminosae, subfamily Caesalpinoideae) Genus of giant trees in which the leaves are pinnate. The flowers are tiny, regular, and pentamerous. The pod is flat, tardily dehiscent, and contains one seed surrounded by a papery wing. There are three species, occurring in lowland rain forests, but with a disjunct range, two species being found in W. Malesia, and one in New Guinea.

Köppen climate classification System devised by W. Köppen in 1918, with modifications that were completed in 1936, by which climates are divided into six broad groups according to the major vegetation types associated with them, broadly determined by critical temperatures and the seasonality of precipitation. For example, a summer temperature of 10 °C defines the poleward limit of tree growth; a winter temperature of 18 °C is critical for certain tropical plants; a temperature of −3 °C indicates some period of regular snow cover. The groups are: (A) tropical rainy climates with temperatures in the coldest month higher than 18 °C; (B) arid climates; (C) warm, temperate, rainy climates in which temperatures in the coldest month are between 3 °C and 18 °C, and in the warmest month higher than 10 °C; (D) rainy climates typical of boreal forest, in which temperatures in the coldest month are lower than −3 °C (in US usage modified to 0 °C), and in the warmest month higher than 10 °C; (E) tundra, in which temperatures in the warmest month are 0–10 °C; (F) permanent frost and icecaps, in which temperatures in the warmest month are below 0 °C. Subsets of the main classes are: absence of a dry season (f); a dry summer season (s); a dry winter season (w); a monsoon climate, with a dry season and rains at other times (m). Arid climates (B) are subdivided into semi-arid steppe-type (S), and arid desert (W). The temperatures within class (B) are indicated as: mean annual temperature higher than 18 °C (h); mean annual temperature lower than 18 °C with the warmest month higher than 18 °C (k); mean annual temperature and warmest month both lower than 18 °C (k′). Some criticism of the system centres on its arbitrary criteria of temperature associated with fixed boundaries, and the failure of data on temperature and precipitation to account fully for the effectiveness of the precipitation. *See also* Strahler climate classification; and Thornthwaite climate classification.

Kornberg enzyme The enzyme DNA polymerase, isolated from *Escherichia coli* in 1958 by A. Kornberg and his colleagues. It functions in repair synthesis of damaged DNA.

Korthalsia (family Palmae) Genus of climbing palms (rattans) in which the leaves have an ocrea and a terminal spiny whip, and the leaflets are diamond-shaped, their upper margins toothed. The inflorescences are terminal (the stem dying after flowering), and burst through the leaf sheath. The flowers are hermaphrodite, and single. The fruits are scaly. The stems are hard and durable, and are widely utilized, and sometimes sold. There are about 31 species, found in rain forests from Burma to New Guinea.

kosava Local wind in the Danube valley. The term is also used in a generic sense to refer to a type of ravine wind.

Kotlassia prima Amongst the amphibians a few genera referred to the Seymouriamorpha show many developments that suggest they were evolving towards the reptilian condition. Some palaeontologists believe that these animals have attained the 'half-way' stage in the evolution of the first reptiles. Others, however, including Panchen, claim that *Kotlassia* and its relatives retain a lateral-line system and a tadpole stage in the early part of their life cycle. *Kotlassia*, known from the Upper Permian, is one of the last survivors of this important stock.

Kraemeriidae (sand gobies; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, rarely freshwater, fish, with a usually scaleless body, small eyes and, typically, a strongly projecting lower jaw. Both dorsal and anal fins are long. Sand gobies are very small, burrowing fish, inhabiting sandy shallow waters. A typical example is *Kraemeria bryani* (2.5 cm), from Hawaii. There are about ten species, found in the Indo-Pacific region.

kraits *See Bungarus.*

Krakatau *See* Krakatoa.

Krakatoa (Krakatau) Small volcanic island between Java and Sumatra. The volcano erupted in 1883, destroying the entire biota. Recolonization of the island by plants and animals has been extensively studied. The vegetation succession commenced with communities of blue-green algae, ferns, and other herbaceous vascular plants; through to savannah, shrub communities, and woodlands of xerophytic trees; and ultimately to a climax of rain forest like that which clothed the island prior to 1883.

Krebs cycle *See* citric-acid cycle.

krill Shrimp-like, marine, euphausiid crustaceans, dense swarms of which occur in ocean waters. They feed on diatoms and themselves comprise the main food of filter-feeding whales. Krill are up to 5 cm in length and are found in both surface and bottom waters.

kronism The killing and eating of offspring.

Kronosaurus During the Late Jurassic and Lower Cretaceous gigantic aquatic reptiles such as *Kronosaurus* were among the major predators in the marine environment. *Kronosaurus* is a short-necked, large-headed pliosaur. Individuals grew to 12–15 m long. *Kronosaurus* is recorded from the Upper Cretaceous of Australasia.

krotovina (crotovina) Animal burrow that has been filled with organic or mineral material from another horizon.

krummholz Gnarled, stunted, and usually bush forms of trees, typically conifers, which grow in the kampfzone between waldgrenze and baumgrenze. Krummholz trees can also be found at relatively low altitudes, whenever there is marked exposure to strong winds.

Kryptopterus bicirrhis (glass catfish) *See* Siluridae.

***K*-selection** Selection for maximizing competitive ability, the strategy of equilibrium species. Most typically this is a response to stable environmental resources. This implies selection for low birth rates, high survival rates among offspring, and prolonged development. *K* represents the carrying capacity of the environment for species populations showing an S-shaped population-growth curve. *See* S-shaped growth curve; *compare* *r*-selection.

Kuehneosaurus latus First of the eolacertalians, flying lizards which flourished during the Late Triassic. Essentially these were of ancestral stock, but the outward extension of the ribs indicates a specialized adaptation towards gliding.

Kuhlia taenuria (five-banded flagtail) *See* Kuhliidae.

Kuhliidae (flagtail; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of often silvery fish which have large eyes, and a distinct notch between the two dorsal fins. The forked tail-fin may show oblique black bands ('flagtail'). *Kuhlia taeniura* (five-banded flagtail) frequents coastal waters, reaching a size of 20 cm. In Polynesia it is used as bait for trolling lines (fishing lines towed behind boats). There are about 12 species, found in the Indo-Pacific region, some in fresh water.

kuhli loach (*Acanthophthalmus kuhlii*) *See* Cobitidae.

kumquat *See Fortunella*.

kunzite *See* spodumene.

Kuroshio current Oceanic surface current that flows northwards from the Philippines, along the Japanese coast, and then out into the N. Pacific. It is an example of a western boundary current: fast-flowing (up to 300 cm/s), narrow (less than 80 km), and relatively deep.

Kurtidae (nursery fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of mainly brackish-water fish which have a compressed, deep body, tapering sharply towards the tail; an oblique mouth; and a single dorsal fin. The anal fin is very long but low. The steep head profile is used by males to carry the eggs delivered by the female. *Kurtus gulliveri* (nursery fish), 58 cm, will enter both freshwater and brackish-water regions of rivers in tropical Australia. There are about two species, found in the Indo-Pacific region.

kuru Human disease which occurs naturally only in a small area of Papua New Guinea. The disease involves a progressive degeneration of the central nervous system. It is caused by a virus.

Kutorginida (phylum Brachiopoda) Order of brachiopods with biconvex, calcareous shells, and cardinal areas in both valves. No teeth or sockets are found. In the past this group of Lower Cambrian fossils has been assigned to both the Inarticulata and Articulata classes, but it is suspected to have been derived independently of these classes and in the future may come to be regarded as a distinct class.

kyanite Mineral, specific gravity 3.5–3.6, hardness 4.0–7.0, and with the chemical composition $Al_2(SiO_4)O$. It occurs in alumina-rich rocks that have been subjected to high-pressure metamorphism, and is associated with, for example, corundum, andalusite, and rutile. It is distinguished by its colour and its occurrence in micaceous schists. It is light blue to darker blue, sometimes green or yellow, and occasionally black; and it has a vitreous lustre. It crystallizes in the triclinic system. The crystals are usually long, columnar, often flattened and bladed, with occasional stellate intergrowths. It is used in refractories. *See also* aluminosilicates.

Kyphosidae (sea chub; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which generally have oval-shaped bodies, long and low second dorsal and anal fins, relatively short heads with a small mouth, and forked to emarginate tail-fins. Many species are predominantly plant-feeding, yet put up an energetic fight when caught on a line. *Kyphosus incisor* (yellow chub) of the W. Atlantic is one of the larger species (90 cm). *Girella tricuspidata* (luderick), 40 cm, of E. Australia is one of the many representatives of the family which are regarded highly by fishermen. There are at least 31 species, found throughout the world in warm to temperate waters.

Kyphosus incisor (yellow chub) *See* Kyphosidae.

L

labella *See* labellum.

labellum (pl. labella) In Diptera (true flies), one of a pair of fleshy lobes into which the proboscis is expanded distally. It is often used as an adaptation for imbibing surface liquids.

labial mask *See* mask.

labial palp One of the pair of jointed, sensory structures carried on the lower lip (labium) of the mouth of an insect. They articulate with the part of the labium known as the prementum.

Labia minor (little earwig) *See* Labiidae.

Labiatae Family of herbs or low shrubs, comprising a natural group, whose members have quadrangular stems, and simple leaves without stipules in opposite pairs. Commonly there are apparently whorled spikes of flowers; actually branched cymes are borne in the axils of opposite pairs of bracts, but are usually very condensed. The flowers are strongly irregular, with a five-toothed or two-lipped calyx, and a tubular corolla which is often clearly two-lipped but may have only the lower lip developed; there are two or four stamens, and a four-lobed ovary with the style inserted between the four lobes. The fruit is composed of four, separating, one-seeded nutlets, a clear distinction from those genera of Scrophulariaceae which are superficially similar. Many genera and species are used as flavourings, as they contain aromatic, volatile, essential oils. Some of these oils (e.g. menthol and thymol) are used as mild antiseptics. Many species are cultivated for their flowers, others beautify northern temperate woodlands in springtime. There are some 170 genera, with 3000 species, and their main distribution is in tropical and warmer temperate regions.

Labiduridae (earwigs; class Insecta, order Dermaptera) Cosmopolitan family of rather primitive earwigs, some species of which are winged. Typical labidurids are the robust, red-brown, wingless species that are found in the rain forest of Australia and SE Asia.

Labiidae (earwigs; class Insecta, order Dermaptera) Cosmopolitan family of earwigs, which includes the European species *Labia minor* (little earwig). All species are winged. Labiids are generally small (less than 1.5 cm long) and unremarkable in appearance.

labium *See* labial palp; and mask.

Laboulbeniomycetes (subdivision Ascomycotina) Class of fungi, which are parasitic mainly on insects but also on other arthropods. They appear not to cause their hosts significant harm. The asci are elongated and club-shaped, and typically contain four ascospores. There is one order, containing many genera.

Labracoglossidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have a single dorsal fin (the soft-rayed part of the dorsal and of the anal fins being covered in scales), and a protractile mouth. *Labracoglossa argentiventris* is a common species in Japanese waters and grows to about 25 cm. There are about five species, found in the W. Pacific.

Labrador current Oceanic current that brings cold Arctic waters southwards into the N. Atlantic along the western margin of Greenland. Frequently it carries icebergs southwards to be concentrated in the area to the east of the Grand Banks in late spring to early summer. Fog banks often occur off the coast of Newfoundland where the Labrador current meets the Gulf Stream.

labradorite *See* dolerite.

Labridae (wrasse; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of marine fish, which are very diversified in shape and size. Usually a wrasse has a rather robust body; long and low dorsal and anal fins; and a tail-fin that is rounded or emarginate, but never forked. The thick, protrusible lips and well-developed canine teeth may give the fish a distinctive profile. Most species are brightly coloured, but within a single species the colour pattern may differ according to age, sex, and season. A number of wrasses are hermaphrodites, with females turning into males as they grow older. They range in size from the small *Labroides dimidiatus* (cleaner wrasse 10 cm), to the huge *Cheilinus undulatus* (giant maori wrasse) which grows to 2.3 m. There are at least 400 species, found worldwide in tropical to temperate waters.

Labroides dimidiatus (cleaner wrasse) *See* cleaner fish; and Labridae.

labrum Broad piece of cuticle which forms the upper lip in an insect. The labrum articulates with the clypeus. It is anterior to the mandibles, and can be moved away from them by a pair of muscles, or closed down on to them by another pair of muscles with a rocker-like action.

Laburnum (family Leguminosae) Genus of trees with trifoliate leaves, and leafless, pendulous racemes of yellow pea-like flowers. The fruits are rounded pods containing poisonous seeds. They are cultivated for ornament. There are two species, native to Europe.

labyrinth fish Fish with accessory respiratory organs in the gill chambers which enable them to utilize atmospheric oxygen when necessary. *See also* Anabantidae; Belontiidae; and Clariidae.

Labyrinthodontia Subclass of the Amphibia, primitive in character, and ranging in length from

a few centimetres to several metres. They were the Palaeozoic and Triassic amphibians. There are no known connections with other amphibians, but they show affinities with crossopterygian fish and with reptiles.

Labyrinthulales (class Hydromyxomycetes) Order of eukaryotic organisms in which the feeding stage is a net plasmodium. Soluble nutrients are absorbed from the surroundings. Labyrinthulales are found mainly in marine or estuarine environments in association with algae and other plants, upon which they may be at least partially parasitic.

Laccaria (family Tricholomataceae) Genus of fungi in which the fruit bodies are mushroom-like and very variable in colour. *L. laccata* (the 'deceiver') is tawny to brick red; *L. amethystea* (the 'amethyst deceiver') is deep purple-lilac becoming paler on drying. The spore print is white; spores typically appear spiny under the microscope. There are many species, found on the ground in woods, heaths, etc.

Lacciferidae (order Hemiptera, suborder Homoptera) Family of bugs, related to the Coccidae, in which the females are legless and have greatly reduced antennae. The Indian *Laccifer lacca* (lac insect) lives clustered on the twigs of various trees, and the body of the female is enclosed in a 'shell' of a resinous secretion from which shellac is made.

Laccifer lacca (lac insect) *See* Lacciferidae.

laccolith Concordant, lenticular pluton, which is circular or elliptical in plan. The floor is essentially flat, but the roof is distinctly domed.

lacebug *See* Tingidae.

Lacerta (lacertids; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Genus of typical lizards, which have tiny dorsal scales, increasing in size on the flanks. The ventral plates are broad and smooth, and there is a well-defined scaly collar. The hemipenis of the male typically has small sulcal lips. There are some 32 species, occurring in Europe, N. and W. Asia, and northern and tropical Africa.

Lacerta agilis (sand lizard; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Lizard which grows to 25 cm long, and has large brown dorsal blotches. The male has green flanks. Sand lizards feed principally on insects and spiders. The female lays 3–14 eggs. It inhabits Europe and W. Asia. In Britain it is restricted to Lancashire coastal dunes and southern heathlands, and is legally protected.

Lacerta lepida (eyed lizard, ocellated lizard; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) The largest European lacertid, which grows up to 70 cm long. The thick-set body has 13–24 blue spots on each flank. The female lays 6–10 eggs. It is found in S. France, Liguria (Italy), Iberia, and NW Africa.

Lacerta viridis (green lizard; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Large, stocky lizard, which grows to 40 cm long. The male is green, stippled with black; the female is green or brown, sometimes striated. The species occurs in C. and S. Europe; although absent from Britain it is present on Jersey and Guernsey.

Lacerta vivipara (common lizard, viviparous lizard; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Lizard which grows to 18 cm long. Usually it is brown or grey-brown, with darker and lighter spots; often there is a dark vertebral stripe. It feeds mainly on spiders and insects. It is ovoviviparous (producing 3–15 young). It occurs in variable habitats in the British Isles, Ireland, continental Europe, and temperate Asia.

Lacertidae (true lizards; order Squamata, suborder Sauria (Lacertilia)) Family of small, agile lizards, all of which have well-developed legs, and long tails capable of autotomy. The head plates are fused to the skull bones. There are more than 200 species, occurring in Europe, Asia, and Africa, some within the Arctic Circle.

Lacertilia *See* Sauria.

lacewings 1 *See* Neuroptera. 2 (green lacewings) *See* Chrysopidae.

lachrymal Small bone near the centre of the face, situated just within or just outside the orbit, and often perforated to accommodate the lachrymal duct.

lacinia mobilis In Peracarida, a mobile, tooth-like process on the mandible.

laciniate Deeply cut, into irregular, narrow segments or lobes.

lac insect (*Laccifer lacca*) *See* Lacciferidae.

Lac operon Operon that controls the synthesis of acetylase, permease, and beta galactosidase, three enzymes involved in the metabolism of lactose in *Escherichia coli*. The Lac operon is a cluster of structural genes specifying the above enzymes. These genes are controlled by the co-ordinated action of *cis*-dominant promoter and operator regions, the activity of which is in turn determined by a repressor molecule that is specified by a separate regulator gene. Most of the detailed discovery of this system was worked out by François Jacob and Jacques Monod during the late 1950s and early 1960s; the Lac-operon DNA was isolated in pure form in 1969.

Lactariidae (false trevally; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, with an oblong, compressed body, and an oblique, large mouth with a prominent lower jaw. The pectorals are long and pointed, the tail-fin forked. *Lactarius lactarius* (24 cm), found in the Indo-Pacific region, is of some commercial importance in India and Malaysia. Two species are known.

Lactarius 1 (family Russulaceae) Genus of fungi in which the mushroom-shaped fruit bodies exude a milky latex when damaged. The gills are decurrent. There are numerous species, some of which are edible, others being poisonous. They are found on the ground under trees. 2 (family Lactariidae) See Lactariidae.

lactic acid Three-carbon hydroxy-acid, formed as the major metabolic product of certain bacteria, and also from pyruvic acid in animal cells when glycolysis occurs under anaerobic conditions.

Lactobacillaceae Family of Gram-positive bacteria in which the cells are straight or curved rods; most are non-motile. They are chemo-organotrophic, have complex nutritional requirements, and are found in various habitats where carbohydrates are available as nutrients. They rarely cause disease. Some strains are used in the manufacture of certain dairy products, e.g. yoghurt and cheese.

lactogenic hormone *See* corpus luteum; and prolactin.

Lactoridaceae (order Laurales) Family of only one species, *Lactoris fernandeziana*, a shrub endemic to the Juan Fernandez Islands, off the S. American coast. The leaves are small, alternate, with stipules. The plants are monoecious, but the flowers may be unisexual or bisexual. They comprise just three sepals, six stamens, and three carpels, and develop into follicles.

lactose (milk sugar) Disaccharide sugar comprising glucose and galactose; it is the principal sugar in milk.

Lactuca sativa (lettuce) *See* Compositae.

lacunose Having a surface pitted with cavities or indentations.

lacunosus From the Latin *lacunosus* meaning 'with holes', a variety of cloud usually associated with the genera altocumulus and cirrocumulus. Thin layers or sheets of cloud display a fairly regular set of holes with frilled edges, so forming a net. *See also* cloud classification.

LAD *See* last-appearance datum.

lady-beetle *See* Coccinellidae.

ladybird *See* Coccinellidae.

ladybug *See* Coccinellidae.

ladyfish (*Elops saureus*) *See* Elopidae.

lady's mantles *See Alchemilla*.

Laemobothriidae (order Phthiraptera, suborder Amblycera) Family of chewing lice which are parasitic on birds of the orders Anseriformes and Falconiformes, and on the hoatzin (*see* Opisthocomidae). Species in the Laemobothriidae differ from other Amblycera in having the dorsum of the head sculptured, with peg-like processes laterally; these structures are of unknown function. The family includes the largest of all lice, some being as long as 11 mm. There is only one genus in the family, *Laemobothrion*, the three subgenera of which each parasitize one of the three host groups. There are 14 species.

Laetiporus (family Polyporaceae) Genus of fungi in which the fruit body is spongy or softly corky in texture, and bears sulphur-yellow or coral-red pores. The generative hyphae lack clamp connections. There are four species, found on living or dead timber. *See also* sulphur fungus.

Laganina (order Clypeasteroida) Suborder of flattened or inflated sand-dollars with narrow, continuous interambulacra terminated by a single plate next to the apical system. They first appeared in the lowermost Tertiary.

Lagerstroemia (family Lythraceae) Genus of trees in which the leaves are opposite, with conspicuous, pointed, axillary buds. The flowers are held in big terminal panicles, and are showy, purple to pink in colour, with six crinkled petals and many stamens. The fruits are woody capsules seated on a persistent calyx. Several species are widely planted as showy ornamentals. *L. speciosa* also produces the timber pyinma, which is ring-porous, and prized for boat building. There are 53 species, occurring from India to N. Australia. They are most common in seasonally dry SE Asia.

Lagomorpha (Duplicidentata; infraclass Eutheria, cohort Glires) Order comprising the families Eurymylidae (containing extinct forms), Ochotonidae (pikas), and Leporidae (rabbits, cottontails, and hares). The lagomorphs are believed to have diverged from a primitive eutherian stock at the same time as, or soon after, the rodents, so that similarities between lagomorphs and rodents may be very superficial. There is a single record from the late Palaeocene of Mongolia, but the order is not encountered again until the late Eocene, after which it spread widely in N. America and Eurasia. Ancestors of modern lagomorphs, very similar to modern forms, lived during the Oligocene. The incisors grow continually, but to either side of those of the upper jaw there is a small, peg-like incisor that gave the order its old name of Duplicidentata. There is a wide diastema (gap) between the incisors and the cheek teeth. The premolars and molars have sharp edges and are used for cutting rather than grinding, the upper teeth biting outside the lower teeth. The nostrils can be closed and are surrounded by naked skin which may be covered by surrounding fur. There are four or five digits on the hind limbs and five on the forelimbs. The tail is reduced and may not be visible externally. Like some rodents, lagomorphs pass food twice through the alimentary canal (caecotrophy) and will die if prevented from doing so: probably the soft pellets, taken directly from the anus at night and stored in the stomach to be mixed with food taken during the day, contain metabolites produced in the caecum that are essential for digestion.

lagoon Coastal body of shallow water, characterized by a restricted connection with the sea. The water body is retained behind a reef or islands.

Lagopus (grouse; family Tetraonidae) Genus of plump, medium-sized, brown, white, or brown and white game birds which have a red eye-wattle, and feathered tarsi. Brown breeding plumage is moulted into a white winter plumage in all but *L. lagopus scoticus* (red grouse). Grouse inhabit heather moorland, tundra, and woodland, feed on ground vegetation, twigs, and berries, and nest on the ground. There are three species, found in the northern regions of N. America, Europe, and Asia.

Lagos rubber (*Funtumia elastica*) *See Funtumia*.

Laguncularia *See* Combretaceae.

lahar Catastrophic mudflow on the flank of a volcano. It is a notable feature of the volcanic areas of Indonesia, especially Java.

LAI *See* leaf-area index.

lake forest Forest dominated by conifers, which occurs in the eastern half of N. America, in Minnesota, Michigan, N. Pennsylvania, S. Ontario, and northern New England. Although a distinct formation it is in many respects transitional between boreal coniferous forest and southern deciduous forest. Very little lake forest survives, having been cut in the latter part of the nineteenth century.

Lalage sueurii (white-winged triller) *See* Campephagidae.

Lama (guanaco, llama) *See* Camelidae.

Lamarck, Jean Baptiste Pierre Antoine de Monet, Chevalier de (1744–1829) French naturalist who, in 1809, advanced the theory that evolutionary change may occur by the inheritance of characteristics acquired during the lifetime of the individual. For example, fossil evidence suggests that the ancestors of the giraffe had short necks: Lamarck proposed that competition for food encouraged them to stretch upward in order to browse among higher vegetation, causing their necks to lengthen, and that this lengthening was passed on to their descendants. Over millions of years the minute increases from each generation to the next culminated in the long-necked form. *Compare* Darwin, Charles Robert.

Lamarckism The theory of evolution propounded by Lamarck.

Lambeophyllum profundum One of the earliest recorded rugose corals from the Upper Ordovician of N. America. The majority of early solitary corals were rather small and horn-shaped. They belonged to the subclass Rugosa and were noted for the presence of well-defined radiating partitions: the septa.

Lamb's dust-veil index Index of the amount of finely divided material suspended in the atmosphere after great volcanic eruptions, and of the duration of an effective veil intercepting the Sun's radiation. It can be calculated from estimates of the amount of solid matter thrown up, or from the reduction of intensity of the solar beam, or from the reduction of temperatures prevailing at the surface of the Earth. The latitude of the volcano affects the index values also, because the maximum extent of the veil over the Earth varies, being greatest after eruptions in low latitudes. (The great eruption of Krakatoa in Indonesia in 1883 gave an index value of 1000.)

lamella 1 One of the membranes that comprise thylakoid discs in chloroplasts. Those in adjacent grana often appear interconnected. 2 Thin layer that forms part of the matrix of bone. 3 *See* gill.

lamellate bill In birds, a bill with special plates adapted for sieving out food items, found in Anatidae and Phoenicopteridae.

Lamellibranchia *See* Pelecypoda.

lamina Flat, sheet-like structure, e.g. the blade of a leaf.

laminar flow Type of flow (normally in water) characterized by the movement of particles parallel to each other, with no transverse movement or mixing. Velocity increases steadily away from the bed. Laminar flow is found only at low velocities and adjacent to smooth surfaces.

Laminaria (order Laminariales) Genus of brown seaweeds in which the thallus consists of a holdfast, a stipe, and a flattened blade which may or may not be divided. They are found mainly on lower shores and in shallow coastal waters, usually attached to rocks; they are usually exposed only at the very low spring tides. *See also* oarweed; sea-belt; and tangle.

Laminariales (class Phaeophyceae) Order of brown seaweeds in which there is a heteromorphic alternation of generations, with a large sporophyte and a microscopic gametophyte. The sporophyte is usually differentiated into holdfast, stipe, and blade. There are four families, and many genera, found mainly in cold and temperate seas.

laminate Comprising layers of material.

Lamnidae (mako, basking shark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Small family of marine sharks which have stout, streamlined bodies. The first dorsal fin is placed midway on the back, but the second dorsal and anal fins are small and near the tail-fin. Distinct ridges or keels are present on each side of the caudal peduncle. Among the species considered dangerous are *Carcharodon carcharias* (white shark), 6.4 m, and *Isurus oxyrinchus* (mako shark), 3.6 m. The very large *Cetorhinus maximus* (basking shark), 10 m, is a relatively harmless animal. Some workers place certain species in different families. There are about 14 species, distributed worldwide.

Lamniformes Order of sharks (not recognized by all authorities) possessing two dorsal fins without spines and, typically, an anal fin. There are five pairs of gill slits; a spiracle is present in most species. The order includes a variety of sharks, e.g. Orectolobidae (carpetsharks), Lamnidae (mako sharks), and Scyliorhinidae (catsharks). There are about 200 species, worldwide in distribution.

lampbrush chromosome One of the large chromosomes found in the eggs (primary oocytes) of amphibians, with paired loops which extend from most of their chromomeres, giving a furry, brush-like appearance under the microscope. They are particularly obvious at the diplotene stage of meiosis.

lamper eel *See* Amphiumidae.

lamprey *See* ammocoete; and Petromyzonidae.

Lampridae (opah; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Family comprising one species of marine fish which not only is large (1.8 m) but has an unusual body profile. *Lampris guttatus* (opah, or moonfish) has a greatly compressed, oval or almost round body, a small mouth, long first dorsal and pelvic fins, and

a narrow tail ending in a forked tail-fin. Despite the attention it draws because of its size and shape, little is known about its biology. It is distributed worldwide.

Lampridiformes Order of marine fish of widely differing shape and form, ranging from the deep-bodied Lamprididae (opah) to the eel-like Regalecidae (oarfish). They have a unique type of protrusible jaw, fins without true spines, and a rather small mouth. Some families (e.g. Mirapinnidae) have also been placed in another order.

Lampris guttatus (opah, moonfish) *See* Lamprididae.

lamp shell *See* Brachiopoda.

Lampyridae (glow-worms, fire-flies, lightning beetles; class Insecta, order Coleoptera) Family of beetles in which the male elytra are soft and pubescent, and the eyes large. Females resemble larvae; the body is elongate, often without wings or elytra, and the eyes small. The antennae are filiform. Larvae are tawny, the body segments are expanded, the head is small and concealed, the mandibles are large. They feed on slugs and snails, which they inject with digestive juices. All stages are luminous, but this is most pronounced in adults; light is produced from the end of the abdomen to signal a mate (*compare* Elateridae). There are 1700 species.

lancelet *See* Branchiostomidae.

land and sea breezes Circulations of air common along coasts, caused by a low-level pressure gradient due to the differential heating of land and sea. On summer days, solar radiation warms the land surface more strongly than the adjacent sea: a pressure gradient from sea to land results in a gentle, cooling, landward 'sea breeze' whose maximum strength is usually developed by late afternoon. Upward movement of warm air over the land and movement toward the sea at greater height, followed by subsidence, produces a shallow convection cell. At night and in early morning cooler land and relatively warmer sea produce a reverse-flow convection cell, with a seaward 'land breeze'. The horizontal extent of well-developed land and sea breezes is typically limited to about 40 km, but associated air movements can often be detected over a much wider coastal belt.

land bridge Connection between two land masses, especially continents, that allows migration of plants and animals from one land mass to the other. Before the widespread acceptance of continental drift, the existence of former land bridges was often invoked to explain faunal and floral similarities between continents now widely separated.

land crabs *See Cardiosoma guanhumi*; and Gecarcinidae.

landlocked fish Marine fish which no longer migrate back to the sea, but have become established permanently in freshwater lakes and drainage basins. There are, for example, landlocked populations of *Salmo salar* (salmon) in parts of N. America and Sweden.

landnam Characteristic horizon in the pollen chronologies of Britain and W. Europe, and also found elsewhere though at different stratigraphic dates. The absolute quantity of tree pollen in relation to that of other plants is greatly reduced. Sometimes a charcoal layer is found at a similar stratigraphic level. The non-tree pollen shows an increase in arable weed species, e.g. plantain and nettles, and cereal pollens are first recorded in some abundance at this level. Together with archaeological evidence, the horizon is strongly suggestive of a first phase of deliberate forest clearance by Neolithic agriculturists. The landnam phase is dated to about 5000 BP throughout NW Europe.

landscape architecture Branch of architectural studies that is particularly concerned with design in relation to the scenic environment, e.g. the use of appropriate tree species to blend with buildings or landscape morphology, the harmonious design of way-marking, shelters, etc.

landscape evaluation The assessment of landscape as a scenic resource. It is controversial, since such concepts as 'scenic beauty' are neither generally agreed nor readily quantifiable. Nevertheless evaluations are vital for the conservation of high-quality and/or traditional landscapes, especially in densely populated, developed regions.

landslide *See* mass-wasting.

Langermannia gigantea *See Calvatia*.

langur (*Presbytis*, *Pygathrix*, *Rhinopithecus*) *See* Cercopithecidae.

Laniidae (shrikes; order Passeriformes) Family of mainly black, grey, or brown and white birds which have a strong, hooked bill, well-developed rictal bristles, strong legs, and a long, narrow tail. They inhabit open areas and woodland edges, and feed on insects, reptiles, mammals, and birds, many species impaling their prey on thorns. They nest in bushes and trees. There are 12–13 genera, with 78–82 species, many migratory, found in Europe, Asia, Africa, and N. America. The helmetshrikes are often placed in a separate family, Prionopidae.

Lanius (shrikes; family Laniidae) Genus of predominantly grey or brown shrikes, many of which have black facial masks. They feed from exposed perches, sometimes hovering to drop on their prey. There are about 65 species, found in Europe, Asia, Africa, N. America, and New Guinea.

Lansium (family Meliaceae) Genus of small trees in which the leaves are pinnate. The fruit is a berry with 1–5 seeds surrounded by fleshy pulp. There are 1–5 variable species occurring in W. Malesia, several of which are cultivated for their edible fruit.

Lantana (family Verbenaceae) Genus of shrubs which produce showy flower heads. Several are cultivated as ornamentals. There are 150 species, occurring in tropical America and Africa. Several are now pantropical; and *L. camara* is a pernicious weed.

lanterneye fish *See* Anomalopidae.

lanternfish *See* Myctophidae.

lantern fly *See* Fulgoridae.

lanthanide *See* rare-earth element.

Lanthanotidae (earless monitor; order Squamata, suborder Sauria (Lacertilia)) Monospecific family comprising *Lanthanotus borneensis*, from Borneo, which is an elongate lizard with short limbs, and a long tail with no autotomy. It grows up to 43 cm long. The lower eyelid is transparent. The lizard feeds on fish and invertebrates. It burrows and swims. It may be a survivor of the lizard group ancestral to snakes.

Lanthanotus borneensis (earless monitor) *See* Lanthanotidae.

lapiés Variety of karren, consisting of shallow, straight grooves incised by solution into a sloping surface of limestone. It may constitute a dense, sub-parallel network which develops rapidly upon exposure of the limestone.

lapilli Volcanic fragments or tephra ranging in size from 4 to 32 mm.

Laportea (family Urticaceae) Genus of trees or bushes whose leaves have highly irritant stinging hairs. There are 23 species, which are mainly tropical and subtropical in distribution, with some occurring in northern temperate regions.

Lapparentophis defrennei One of the earliest snakes, which appeared first during the Cretaceous Period (Albian).

lappet moths *See* Lasiocampidae.

lapse rate Rate of decrease of temperature per unit height in the atmosphere. In the troposphere the average rate is approximately 6.5 °C/1000 m. *See also* adiabatic; and environmental lapse rate.

lapwings *See Vanellus*.

larch 1 *See Larix*. 2 (golden larch) *See Pseudolarix*.

larder beetle (bacon beetle, *Dermestes lardarius*) *See* Dermestidae.

large-eye bream *See* Pentapodidae.

large house spider (*Tegenaria domestica*) *See* Agelenidae.

largemouth bass (*Micropterus salmoides*) *See* Centrarchidae.

largenose fish *See* Megalomycteridae.

large red damselfly *See Pyrrhosoma nymphula*.

large white butterfly *See Pieris brassicae*.

Laridae (gulls, terns; order Charadriiformes) Family of small to fairly large birds, most of which are grey and white, although some have black on the head and wings. The bill is slender to heavy, the wings long and pointed, the tail square or forked, and the feet webbed. They are found on coasts, rivers, lakes, and marshes, where they feed on fish, crustaceans, molluscs, insects, and carrion. They nest on the ground, on cliffs, and in trees. There are 11–17 genera, with about 90 species, most migratory, and found worldwide.

Larix (larches; family Pinaceae, tribe Abietineae) Genus of coniferous trees with soft, deciduous leaves in tufts, mostly on short spur shoots, and oval, persistent cones. There are about 12 species found in the cold temperate parts of the northern hemisphere.

larks 1 *See* Alaudidae; *Calandrella*; and *Galerida*. 2 (bush larks) *See Mirafra*. 3 (magpie larks) *See* Grallinidae.

larkspur *See Delphinium*.

Larus (gulls; family Laridae) Genus of small to fairly large, mainly grey and white birds, many of which have black or dark brown hoods. Their bills vary from slim to stout, and are coloured yellow, red, or black. Immature birds are darker and browner. They are gregarious and nest colonially. There are 38–45 species, found worldwide.

larva Stages in insect development that occur after hatching from the egg, and prior to the reorganizations involved in becoming adult. The term is applied loosely to all exopterygote and endopterygote insects at this stage of growth and feeding, although the term 'nymph' is frequently applied to exopterygotes. *See also* pupa.

larynx In tetrapods, a dilated region of the upper trachea at the junction with the pharynx, often possessing a folded membrane (vocal cords) which can be made to vibrate and so produce sound, the pitch of the sound being controlled by stretching or relaxing the cords.

Lasiocampidae (lappet moths, eggars; order Lepidoptera) Family of medium-sized to large moths in which the body is stout and hairy, the proboscis absent, and the antennae bipectinate. Generally females are larger and slower-flying than males. Larvae are densely hairy, with downward-directed tufts and a fringe. The pupa is in a whitish, parchment-like cocoon. Distribution is worldwide, but the moths are absent from New Zealand.

Lasioglossum *See* Halictidae.

Lasiopetalum (family Sterculiaceae) Genus of soft-wooded trees and shrubs, with simple or slightly-lobed, alternate leaves. The flowers are borne in complex cymes. There are 30 species, all of them endemic to Australia, where they are found mainly in central southern and eastern areas, often in well-developed dune communities.

Lassa fever Rare viral disease of humans, first recorded from Nigeria and subsequently occurring in a few travellers from Africa. The infection is systemic, involving various organs, and is frequently fatal. It is caused by an arenavirus.

last-appearance datum (LAD) The last recorded occurrence of a key taxon in biological history.

Latania (family Palmae) Genus of big fan palms in which the leaves are greyish and stiff. The plants are dioecious. The inflorescence consists of pendulous spikes. The fruits contain 1–3 stony seeds. There are three species, occurring in the Mascarene Islands (Indian Ocean). They are widely cultivated.

late blight of potato (potato blight) Widespread and serious disease affecting the potato and related plants. Symptoms include the appearance of brown

patches on the leaves, often with white mould on the under-sides. Under damp conditions the entire foliage may collapse. Brown lesions also develop on tubers, spreading to involve the entire tuber in a dry rot. The disease is favoured by wet weather. It is caused by the fungus *Phytophthora infestans* and was responsible for the Irish potato famine in the 1840s.

Late-Devensian Interstadial *See* Windermere Interstadial.

late-glacial Term usually applied to the time between the first rise of the temperature curve after the last minimum of the Devensian glaciation, and the very rapid rise of temperature that marks the beginning of the post-glacial, or Flandrian period. The Late Devensian extends from about 15 000 to 10 000 BP and shows a characteristic three-fold climatic and hence depositional sequence, from cold, older *Dryas* deposits, to warmer Allerød, to colder, younger *Dryas*. In Europe there is some evidence for an additional warmer phase, the Bølling interstadial, dating about 13 000 BP, i.e. during older *Dryas* times. Some authorities consider that this partial warming sequence may be characteristic of the late-glacial times of all major glacial advances.

lateral-fold lizards *See* Anguidae.

lateral line System of receptors, often embedded in special grooves in the skin, capable of detecting movement and vibrations in the water surrounding the animal. In most fish, the lateral line runs along the sides of the body, but usually it forms a number of branches on the head. It is found in all lower aquatic vertebrates and some Amphibia.

lateral moraine *See* moraine.

laterite Weathering product of rock, composed mainly of hydrated iron and aluminium oxides, hydroxides, and clay minerals, but also containing some silica. It is related to bauxites and is formed in humid, tropical settings by the weathering of such rocks as basalts. *See also* plinthite.

laterotergite In an insect, one of a number of lateral flanges associated with the tergites. They are usually found on all the pregenital tergites.

Lates calcarifer (giant perch) *See* Centropomidae.

latex White, commonly sticky, substance produced in specialized tissues within a plant.

Lathyrus (sweet pea, vetchling; family Leguminosae) Genus usually of herbs that climb by leaf tendrils, and commonly have two pairs or one pair of leaflets (sometimes none) on each leaf. The stems are often winged or angled; the style is flattened and bearded above. Many are cultivated for their flowers, or more rarely for the edible seeds of some species. There are about 110 species, occurring in the northern temperate zone, and in mountains of African and S. American tropics.

Latimeria chalumnae (coelacanth) *See* Actinistia; Coelacanthiformes; and Latimeriidae.

Latimeriidae (coelacanth; class Osteichthyes, subclass Crossopterygii, order Coelacanthiformes) Monospecific family comprising *Latimeria chalumnae* (coelacanth), a large, bulky fish characterized by peculiar stalk- or lobe-like supports for the second dorsal, pectoral, and pelvic fins.

latitudinal vegetation zone Major vegetation belt that coincides with a broad, global, climatic regime. Thus rain forest relates to the equatorial climate, and savannah to the seasonal tropics roughly 10–20° on either side of the equator. The simple pattern is complicated by the effects of altitude, so that in each latitudinal vegetation zone there are found vegetation types more characteristic of latitudes nearer the poles.

Latridae (trumpeter; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have a somewhat elongate body shape, a small mouth with sharp teeth, the dorsal fin with a deep notch between the spinous and soft-rayed parts, and many rays (usually more than 30) in the second dorsal and anal fins. The pectoral and pelvic fins are small, and the tail-fin is forked. *Latridopsis forsteri* (bastard trumpeter), 61 cm, of S. Australia is not very common, but is a good food fish. There are about 10 species, found in S. Australia, New Zealand, and Chile.

Latridopsis forsteri (bastard trumpeter) *See* Latridae.

latrodectism The symptoms of the bite of *Latrodectus mactans* (black-widow spider), which is very painful not at the site of the wound but in the lower abdomen and limbs. In humans, symptoms include elevated blood pressure and heart rate, breathing difficulty, and paralysis. Death may occur through suffocation, although this is rare in humans and antidotes are now available. The poison is a neuromuscular neurotoxin which permanently blocks synapses. Susceptibility varies from species to species.

Latrodectus mactans (black-widow spider, malmignette; suborder Araneomorphae, family Theridiidae) Species of spider which is recognizable by the red hour-glass mark on the ventral surface of its abdomen. Black-widow spiders will suck out scarab beetles several times their own size, and their venom contains protein fractions variously lethal to insects and neurotoxic to mammals. There are many mimics of *Latrodectus mactans* in the Mediterranean area. *See* latrodectism.

lauan *See Shorea*.

laughing frog *See Rana ridibunda*.

laughing thrushes *See Garrulax*.

Lauraceae Family of trees and shrubs (but *Cassytha* is a twining parasite) which have evergreen, alternate or opposite, simple leaves without stipules. The tissues contain aromatic oils. The flowers are regular, small, unisexual or hermaphrodite, and usually trimerous. The ovary is usually superior, and surrounded by a cup-like receptacle. The fruit is a berry or drupe-like, and often enclosed by the receptacle. Many species are valuable as ornamentals, or for timber, oil, or spices. There are 32 genera, with 2000–2500

species, occurring in the tropics and subtropics, and centred in Amazonia and SE Asia.

Laurasia *See* Holarctica.

Laurer's canal (Laurer–Stieda canal) In Platyhelminthes, a short tube connecting the union of the oviduct and yolk duct with a pore on the dorsal surface.

Laurocerasus (family Rosaceae) Genus close to *Prunus* but comprising trees or shrubs with leathery, evergreen leaves, and flowers always in racemes. They are cultivated in shrubberies, etc. There are only a few species, native to S. Europe, SW Asia, and Macronesia.

Laurus (family Lauraceae) Genus of plants whose flowers are borne in cymes, enclosed in leafy bracts. There are two species native to S. Europe (*L. nobilis*, sweet bay, whose leaves are used for condiments and berries in veterinary medicine), and to the Canary Islands and Madeira (*L. canariensis*).

lava Molten rock, normally a silicate, emitted by a volcano. It may be vesicular, glassy, or porphyritic in texture, and varies between acidic and basic in composition. Its behaviour on extrusion and its relief-forming capacity depend largely on its viscosity, which is affected by silica content, temperature, and amount of dissolved gases and solids. Two varieties of lava surface are recognized: 'aa', which shows a jagged, stony clinker, bristling with sharp points; and 'pahoehoe', characterized by a smooth, ropy appearance.

Lavatera (family Malvaceae, tribe Malveae) Genus of perennial and annual herbs with alternate leaves with stipules. The flowers are regular and bisexual. The fruit is a schizocarp and the seeds have little endosperm. *L. arborea* is the tree mallow found on rocky coasts of S. Europe. There are 25 species found in the temperate regions of Australia, C. Asia, N. America and the Mediterranean.

Lavatera arborea (tree mallow) *See Lavatera*.

laver (laver bread) Common name for the edible seaweed *Porphyra umbilicalis* (Bangiales). The thallus is thin and sheet-like, and attached to rocks and other objects in the intertidal zone. *Ulva lactuca* is sometimes known as green laver.

Lavesian The oldest of the various stratigraphic divisions of the British Precambrian. It can be correlated with similarly aged rocks in Greenland and N. America.

layer cloud One of the principal forms of cloud, with flattened, sheet-like appearance and of limited vertical extent. Common types of cloud exhibiting this form are: (a) low-level layer clouds, e.g. fog and stratus; and (b) multi-layered clouds, e.g. altostratus, cirrostratus, and nimbostratus. *See also* cloud classification.

lazurite Mineral, having a specific gravity of 2.3–2.4, hardness of 5.5, and the chemical composition $Na_8(AlSiO_4)_6(SO_4)$, whose name is derived from its colour. It occurs in the contact zones of alkaline, igneous rocks, in association with carbonate rocks, and is also found in alkaline lavas. It is distinguished by its persistent, intense, blue colour. The colour may be intense, deep, azure-blue, violet, light blue, or greenish-blue, and it has a vitreous lustre. It crystallizes in the cubic system. It is usually found in compact, massive form. It is used to make ornaments, bowls, caskets, rings, and statuettes.

leaching Removal of soil materials in solution.

lead *See* radiometric dating.

leading dominant According to the Wisconsin ordination scheme, the species in any given stand or quadrat that has the highest importance value.

leaf Thin, green, expanded organ borne at a node on the stem of a plant, and typically comprising petiole or stalk, and blade or lamina; and subtending a bud in the axil of the petiole. The leaves are the main site of photosynthesis.

leaf-area index (LAI) Of a plant, the total leaf-surface area exposed to incoming light energy, expressed in relation to the ground surface area beneath the plant: e.g. an LAI of 4 means that the leaf area exposed to light is four times the ground surface area.

leaf-area ratio The photosynthetic surface area per unit dry weight of a plant.

leaf beetle *See* Chrysomelidae.

leafbirds *See Chloropsis*; and Irenidae.

leafbug *See* Miridae.

leaf-cutter ant *See* Attini.

leaf-cutter bee Any species of the cosmopolitan family Megachilidae, the female of which cuts leaf pieces for use as material for lining or closing the nest. Sometimes the leaf fragments are augmented with mud or resin. The leaf-cutter bees include some species of *Chalicodoma* and *Creightonella*, but the most important genus is *Megachile*.

leaf-fish (*Monocirrhus polycanthus*) *See* Nandidae.

leafhopper *See* Cicadellidae.

leaf insects *See* Phasmatodea; and Phylliidae.

leaflet Each leaf-like part of a compound leaf that is not subtending a bud in the axil of its petiolule.

leaf-mining flies *See* Agromyzidae.

leaf-nosed bat 1 (Old World) *See* Hipposideridae. 2 (New World) *See* Phyllostomatidae.

leaf-rollers *See* Tortricidae.

leaf-rolling grasshoppers *See* Gryllacrididae.

leaf warblers *See Phylloscopus*.

leafy sea dragon (*Phycodurus eques*) *See* Syngnathidae.

learning Acquisition of information or patterns of behaviour other than by genetic inheritance, or the modification of genetically acquired information or behaviour as a result of experience.

leatherback *See* Dermochelidae.

leatherjackets 1 *See* Monocanthidae. 2 *See* Tipulidae.

leather-winged beetle *See* Cantharidae.

leatherwood (*Cyrilla racemosa*) *See* Cyrillaceae.

leathery turtle *See* Dermochelidae.

Leathesia (family Corynophlaeaceae, order Ectocarpales) Genus of brown seaweed which forms small (2.5–5 cm) bulbous growths on rocks or on other seaweeds; at first the bulbs are solid, but later they become hollow. The surface is shiny in living plants. *Leathesia* is common around British coasts, being found on the middle and lower shore from spring to early autumn.

Lebiasinidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Family of freshwater fish which have a slender body, a small mouth, large eyes, and the single dorsal fin positioned half-way along the back. Several species, including *Copeina arnoldi* and *Nannostomus marginatus* (pencil fish) are popular aquarium fish. There are about 34 species, found in S. America.

Lecanora (family Lecanoraceae) Genus of lichens in which the thallus is crustose, sometimes with radiating lobes. The apothecia are characteristically lecanorine. There are many species, found in a wide range of habitats. Some species are more resistant than most lichens to atmospheric pollution. *L. conizaeoides* is one of the most pollution-tolerant of all species of lichens; this species forms greyish-green, granular crusts on bark, wood, rocks, walls, and the like, even within large cities, but is uncommon in areas with clean air.

Lecanoraceae (order Lecanorales) Family of lichens in which the thallus is crustose or squamulose to almost foliose. The apothecia are sessile and lecanorine. There are several genera, found in a range of habitats.

Lecanorales (subdivision Ascomycotina) Order of lichens in which the thallus may be crustose, foliose, or fruticose. The apothecia are typically solitary with open, round discs bearing the hymenium; the asci are thick-walled and normally turn blue when treated with iodine. There are many families, found in a wide range of habitats in most regions of the world.

lecanorine Applied to apothecia of the type produced by lichens of the genus *Lecanora*: this type of apothecium is surrounded by a rim of tissue of the same colour as the thallus, the rim being called the 'thalline margin'.

Leccinum (family Boletaceae) Genus of fungi in which the fruit bodies are mushroom-shaped and the hymenium lines tubes opening by pores on the under-side of the cap. The cap surface is dry, not slimy; and the stipe is long and covered with lines or scales which darken with age. There are many species, found on the ground in association with trees.

Lecideaceae (order Lecanorales) Family of lichens in which the thallus is crustose or squamulose. Apothecia are sessile. There are many genera and species, found on a wide variety of substrates. They are cosmopolitan in distribution.

lecideine Usually applied to apothecia of the type produced by lichens of the genus *Lecidea*: this type of apothecium lacks a margin of thalline tissue, although the upper edge of the excipulum may be visible as a rim (the proper margin) similar in colour to the disc of the apothecium.

Lecidia (family Lecideaceae) Genus of lichens in which the thallus is crustose and may be more or less immersed in the substratum. Spores are colourless and aseptate. Apothecia are characteristically lecideine. There are many species. Individual species can usually be recognized only by microscopic examination. They are found on a wide range of substrates.

lecithin One of a group of phospholipid compounds, also known as phosphatidyl cholines, found in higher plants and animals.

lectin Generic term for proteins extracted from some molluscs, fish, and plants (especially legumes), that exhibit antibody activity by effecting the agglutination of red blood cells. Some are mitogenic, while others are capable of causing the preferential agglutination of cancer cells.

lectotype One of a collection of syntypes which, subsequent to publication of the original description, is chosen and designated through published papers to serve as the 'type specimen'.

Lecythidaceae Family of trees in which the leaves are simple and crowded at the twig tips, and rarely have stipules. The flowers are hermaphrodite, and sometimes cauliflorous. There are 4–6 sepals and petals; and many stamens, fused at the base and sometimes strongly one-sided in development; the ovary is inferior, and fused to the receptacle. The flowers are frequently nocturnal, and bat-pollinated. The fruit is a berry or woody capsule, opening by a lid. There are 20 genera, with 450 species, occurring in the tropics and concentrated strongly in S. America.

Lecythis (family Lecythidaceae) Genus of trees whose flowers have a strongly asymmetric androecium. Their oily, edible seeds are known as sapucaia nuts. There are 50 species, occurring in tropical America.

leeches *See* Hirudinea.

lee depression Non-frontal depression that develops on the lee side of an upland barrier across the airflow as a result of contraction leading to cyclonic curvature. Dynamic processes are responsible for the low-pressure system rather than wave development along a front. Such depressions are common, for example in winter on the southern lee side of the Alps.

lee waves Air waves in the lee of a mountain barrier, where a stable layer of air, after displacement by movement over the barrier, returns to its original level. This process results in a series of stationary ('standing') waves extending downwind from the lee side of the barrier. Clouds often form along the wave crests in lenticular form: they may

appear stationary, due to condensation of water vapour at the upward side, caused by the upward air movement, and evaporation on the downward side of the wave. The wavelength can be up to 40 km and the wave amplitude is most pronounced in the intermediate levels of the airstream. Circular air motion (in the vertical plane) beneath the wave crests may reverse wind direction locally within the general air flow. This phenomenon is termed a 'rotor'. In addition to stable air at an intermediate level, lee-wave formation requires a constant wind of at least 15 knots. Well-known wave clouds on the lee side of barriers include the sierra wave of the Sierra Nevada, California, the helm wave of Cumbria, England, and the moazagotl of Silesia.

left-eye flounder *See* Bothidae.

legionary *See* Dorylinae.

Legionella Genus of bacteria which includes the causal agent of legionnaires' disease (*Legionella pneumophila*).

legionnaires' disease Human disease first recognized in 1976 when an outbreak occurred among people attending a convention of the American Legion in Philadelphia. The causal agent was found to be a bacterium which was named *Legionella pneumophila*. Symptoms of legionnaires' disease include fever and pneumonia; the disease may be fatal.

legless lizards *See* Anguidae; Amphisbaenidae; Anniellidae; Cordylidae; Feyliniidae; Pygopodidae; Scincidae; and Teiidae.

Leguminosae Third largest family of flowering plants, comprising trees, climbers, shrubs, and herbs, some of which are aquatic. Innumerable species are of great economic importance for timber, fodder, drugs, or food. The leaves have stipules, and are usually pinnate. Many species have root nodules containing nitrogen-fixing bacteria. The inflorescence is basically racemose. The flowers are regular or zygomorphic, basically with five sepals and petals, the sepals often united. Typically there are 10 stamens (but many in Mimosoideae) which are sometimes fused. The ovary is superior, with a single carpel. The fruit is a pod, usually several-seeded, and usually dehiscent. There are three subfamilies, distinguished by their different flower construction: Caesalpinoideae and Mimosoideae are mainly tropical; Papilionatae has many temperate species and many herbs. There are 700 genera, with 170 000 species, with cosmopolitan distribution.

Leiognathidae (pony-fish, slipmouth; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, which have an oblong and strongly compressed body, large eyes, a small, highly protrusible mouth, and long dorsal and anal fins covering at least half of the dorsal and ventral profiles. When handled, the skin may produce a soapy mucus. Pony-fish are fairly small, *Leiognathus equula* (common pony-fish) of the Indo-Australian region growing to a length of 25 cm. There are about 18 species, frequenting coastal waters of the Indo-Pacific region.

Leiognathus equula (common pony-fish) *See* Leiognathidae.

Leiopelmatidae (class Amphibia, order Anura (Salientia), suborder Amphicoela) Family of primitive frogs which have nine biconcave (amphicoelous) vertebrae, and free ribs. Their eggs, laid on damp ground, develop into froglets before hatching. There are three species, found in the uplands of New Zealand.

Leishmania (family Trypanosomatidae) Genus of protozoa, which are parasitic in vertebrates and insects. There are at least two species. Both species can cause disease in humans, and are transmitted from one human to another by insect vectors.

leishmaniasis Any disease of humans or other animals in which the causal agent is a protozoon of the genus *Leishmania*. For example, *see* espundia; and kala-azar.

lek Territory that is held and defended against rivals by males of certain species of animals during the breeding season. The male displays within its lek in order to attract females into the lek for mating. Females move among the leks, mating with males to whose displays they respond. Consequently, for a local population of a species, leks are usually grouped together within a breeding area and dominant males tend to occupy the more central leks where their displays can be seen by the largest number of females.

lemma *See* Gramineae.

lemming (*Lemmus*) *See* Cricetidae.

Lemnaceae (duckweeds) Monocotyledonous family of freshwater, aquatic, often floating herbs. They are reduced relatives of Araceae, with a disc-like, oval or elliptical, flattened or swollen plant body, not differentiated into stem and leaves, few or no roots, and minute flowers often enclosed in a tiny sheath. The spathe subtends one female and two male, apetalous flowers. The sexes are separate on any one plant and not always produced. There are 2–6 genera, with 22–43 species (depending on the classification) of cosmopolitan distribution.

lemon (*Citrus lemon*) *See Citrus*.

Lemuridae (lemurs; order Primates, suborder Strepsirhini (or Prosimii) infra-order Lemuriformes) Family of mainly nocturnal primates, which are believed to resemble closely the ancestors of modern monkeys, apes, and humans. The brain has small cerebral hemispheres and large olfactory regions, compared with other primates. The snout is long, the upper lip is cleft, and the rhinarium (naked skin surrounding the nostrils) is moist. The eyes are directed more to the side than in other primates and there is little binocular vision. In most species the external ears are large. The upper incisors are small and the lower incisors and canines are directed forward. Lemurs have marked breeding seasons. All modern lemurs are arboreal, herbivorous, and social. Lemurs were distributed widely throughout the warmer regions during the Eocene. Today they survive only in Madagascar,

possibly because the isolation of Madagascar during the Tertiary left it with no native carnivores. There are four genera: *Lemur* (true lemurs), *Varecia* (ruffed lemur), *Hapalemur* (gentle lemur), *Lepilemur* (sportive lemur), with about 15 species.

Lemuriformes (order Primates, suborder Strepsirhini (or Prosimii)) Infra-ordinal name sometimes given to the Malagasy representatives of the Strepsirhini, comprising the most primitive of living primates and their immediate ancestors, grouped into the families Adapidae (extinct forms), Cheirogaleidae (mouse-lemurs), Lemuridae (lemurs), Indridae (indris), and Daubentoniidae (aye-aye). The primitive, insectivore-like features that they retain include a long face, eyes that are directed to the sides of the head, and a brain smaller than that of other primates. Lemur-like animals are known to have lived in both Old and New Worlds from the Lower Eocene. Most authorities now think that the 'lemuriform' characters are those of primitive Strepsirhini, and that despite the fact that they all live on Madagascar, the various families may not be closely related to each other.

Lemuroidea (order Primates) In some classifications a superfamily comprising the lemurs and lorises, placed together in a separate suborder (Strepsirhini) of the primates. In other classifications lemurs and lorises are linked with the tarsiers into the suborder Prosimii. The lemuroids appeared in the Eocene and closely resembled their living descendants.

lemurs The Strepsirhini in general, or just those that live today in Madagascar. Early lemurs (family Adapidae) lived in Europe and N. America during the Eocene. *See also* Lemuridae.

Lentibulariaceae Family of insectivorous herbs. Some are aquatic with insect-trapping bladders or finely divided leaves (e.g. *Utricularia*, bladderworts); some are bog or terrestrial plants with basal rosettes or sticky, insect-catching leaves (e.g. *Pinguicula*, butterworts); some are terrestrial or epiphytic. The flowers are solitary or in racemes on leafless stems, pentamerous, two-lipped, spurred, the petals joined into a tube below (resembling *Linaria*, etc., in the Scrophulariaceae), but the ovary is one-celled. There are five genera, with some 250 species, of worldwide distribution.

lentic Applied to a freshwater habitat characterized by calm or standing water, e.g. lakes, ponds, swamps, and bogs.

lenticel Pore in the stem of a woody plant, showing as a raised spot that may be filled with a powdery substance. The pore permits air to reach tissues below the surface.

lenticular Shaped like a biconvex lens.

lenticularis From the Latin *lenticularis* meaning biconvex or lens-shaped, a form of cloud consisting of clearly defined, elongated lenses. The form is typical of lee-wave clouds and may affect such clouds as stratocumulus, altocumulus, and cirrocumulus. *See also* cloud classification.

Lentinus (family Tricholomataceae) Genus of fungi in which the fruit bodies are tough and have gills with serrated margins. *L. lepideus* can cause decay of timber; *L. edodes* is edible and is cultivated in some parts of the world. *See also* shii-take; and stag's horn fungus.

Lenzites (family Polyporaceae) Genus of fungi, which form bracket-like fruit bodies on the under-side of which are gills bearing hymenium. The spores are colourless, smooth, and cylindrical. There are many species. *L. betulina* forms semicircular or fan-shaped brackets, often in tiers, on deciduous trees and dead wood. *See also Trametes*.

Leo *See Panthera*.

Leonardian The second of the four stages of the Permian in N. America. In some areas it is zoned by the use of fusulinid foraminiferids. It is the N. American equivalent of the Rotliegende. Red-bed localities of Wolfcampian–Leonardian age in Texas and Colorado have yielded many vertebrate fossils.

leopard (*Panthera pardus*) *See Panthera*.

leopard frog *See Rana pipiens*.

leopard snake *See Elaphe situla*.

Lepadidae (goose barnacles; class Cirripedia, order Thoracica, suborder Lepadomorpha) One of seven families of so-called goose barnacles, in which the capitulum has five plates, though some of these may be missing or reduced. There are no articulated caudal appendages, and all known species are hermaphroditic. *Anelasma* has no capitular plates and is entirely parasitic; it sends root-like growths into the tissues of its dogfish hosts.

Lepadogaster candollei (Connemara clingfish) *See* Gobiesocidae.

Lepas anatifera (goose barnacle; order Thoracica, suborder Lepadomorpha, family Lepadidae) Cosmopolitan, oceanic, pedunculate barnacle, which lives attached to a variety of floating objects. As in all lepadids, the stalk is naked, lacking setae or scales, and the main food is diatoms. The barnacle's length is from several to 75 centimetres. It grows rapidly (0.87 mm daily) and in one study attained a pedicle length of 7 cm (contracted) in 113 days. With densities of 400–500 individuals per square metre, *L. anatifera* may cause severe fouling of ships' hulls.

Lepidium (family Cruciferae, tribe Lepidieae) Genus of herbs with alternate leaves without stipules. The inflorescence is usually a raceme, and flowers have four sepals, four petals, and six stamens. The genus is cosmopolitan and found in all arid regions. There are about 150 species, which include *L. sativum*, the common garden cress, which is grown for food.

Lepidium sativum (cress) *See Lepidium*.

Lepidoblepharon *See* Citharidae.

Lepidodendron selaginoides Important species of Palaeozoic plant, characterized by a dichotomous branching, by diamond-shaped leaf scars, and by large cones. During the Upper Carboniferous *Lepidodendron* species flourished on several continents and grew up to 30 m before branching.

lepidolite Mineral, specific gravity 2.8–2.9, hardness 2.0–3.0, and with the chemical composition $K(LiAl)_3(SiAl)_4O_{10}(OH,F)_2$. It occurs in granite, pegmatites, and associated rocks, in association with lithium tourmaline and spodumene. It is distinguished by its cleavage and its lilac to pink colour. It is pale lilac or grey to pale pink, and transparent to translucent, and has a vitreous to pearly lustre. It crystallizes in the monoclinic system. The crystals are usually flaky plates with a well-marked basal cleavage. It is used as an ore for lithium.

Lepidophloios kilpatrickense The earliest known representative of the important Palaeozoic family of plants, the Lepidodendraceae (Lycopsida). Closely related to *Lepidodendron*, *Lepidophloios kilpatrickense* is distinguished by its internal anatomy. It is recorded from the Upper Carboniferous of Scotland.

Lepidopleurina (class Amphineura, subclass Polyplacophora, order Neoloricata) Suborder that includes generally small individuals that may possess very poorly developed insertion plates. Individual plates are often divided into three areas. They first appeared in the Carboniferous.

Lepidoptera (moths and butterflies; class Insecta) Major order of insects, characterized by wings with overlapping scales. The wing-span ranges from less than 5 mm to about 250 mm. Adults generally have a sucking proboscis; rarely they have chewing mouthparts (Micropterigidae). The larvae have chewing mouthparts and are nearly always plant-feeders. The pupae generally lack functional mandibles. Lepidoptera are endopterygotes, with an estimated 165 000 species.

Lepidosirenidae (S. American lungfish; class Osteichthyes, subclass Dipneusti, order Lepidosireniformes) Monospecific family of freshwater fish comprising only *Lepidosiren paradoxa* (S. American lungfish). It has a long, cylindrical body with small scales, small eyes, confluent dorsal and anal fins, and reduced, almost filamentous, pectoral and pelvic fins. It can absorb atmospheric oxygen by utilizing a pair of lungs located beneath the gut. These lungs seem to be even more important for respiration than the gills. During the dry season the fish makes a burrow and becomes dormant. It may reach a length of 1.2 m. It is found in fresh water in S. America.

Lepidosireniformes Order of lungfish with a cylindrical body, paired lungs, and nearly filamentous pectoral and pelvic fins. The larvae have tadpole-like external gills. The order includes the African (Protopteridae) and American (Lepidosirenidae) lungfish, which live only in freshwater basins.

Lepidosiren paradoxa (S. American lungfish) *See* aestivation in fish; and Lepidosirenidae.

Lepidosperma (family Cyperaceae) Genus of sedges with a creeping underground rhizome and aerial stems which are often three-angled in cross-section. They occur in E. Asia and Australia. There are a total of 50 species, of which 40 are found in Australia. *L. gladiatum* (sword sedge) is used to stabilize sand dunes in Australia.

Lepidosperma gladiatum (sword sedge) *See Lepidosperma*.

Lepiota (family Lepiotaceae) Genus of fungi in which the fruit bodies are initially enclosed in a universal veil; there is no volva. Many species are edible. They are found on the ground, on manure, on compost heaps, etc. *See also* parasol mushroom.

Lepiotaceae (order Agaricales) Family of fungi, which form mushroom-like fruit bodies; the stipe can be broken cleanly from the pileus, and the gills are not attached to the stipe. In masses the spores appear olive-green or white. There are five genera.

Lepisma saccharina (silverfish) *See* Lepismatidae; Lepismatoidea; and Thysanura.

Lepismatidae (order Thysanura, superfamily Lepismatoidea) Family of insects which includes some common and cosmopolitan household pests, e.g. *Lepisma saccharina*, which feed on food scraps, carbohydrate and dextrin compounds, glues, and sizes.

Lepismatoidea (order Thysanura, suborder Zygentoma) Superfamily within the Thysanura whose members resemble the Pterygota more closely than those of the other thysanuran superfamily, the Machiloidea. Pterygota and Lepismatoidea have two mandibular articulations, a gonangulum (a sclerite formed from the coxite of the ninth abdominal segment, forming part of the ovipositor), and other morphological similarities. The superfamily occurs throughout the world.

Lepismodes inquilinus (*Thermobia domestica*, firebrat; superfamily Lepismatoidea, family Lepismatidae) Cosmopolitan, thysanuran species which occurs as a pest in human habitations, where it favours warm places, e.g. kitchens and bakeries.

Lepisosteidae (gars; class Osteichthyes, subclass Actinopterygii, order Semionotiformes) Small family of freshwater fish with a slender, cigar-shaped body, and long jaws bearing many teeth. The anal and single dorsal fins are located far back on the body, close to the tail-fin, which is rounded. Living in shallow, weedy waters, gars have a vascularized swim-bladder that enables them to take in air when necessary. Found only in N. America, they range from Quebec Province to Costa Rica and, in the case of *Lepisosteus spatula* (alligator gar) reach a length of 3 m. There are about seven species.

Lepisosteus spatula (alligator gar) *See* Lepisosteidae.

Lepista (family Tricholomataceae) Genus of fungi, which form mushroom-like fruit bodies. The spore print is pale pink; spores appear rough or minutely spiny under the microscope. There are many species, some of which are edible and highly esteemed (*see* blewit). They are found on the ground in woods, hedgerows, gardens, grassland, etc.

Lepomis macrochirus (bluegill) *See* Centrarchidae.

Leporidae (cohort Glires, order Lagomorpha) The family that includes the rabbits, cottontails, and

hares. These are lagomorphs in which the tail is reduced, the hind legs are modified for jumping, and the ears are usually long. Rabbits are adapted for burrowing, and their young are born in burrows, naked and blind. Hares are born above ground, their eyes open, and fully furred. Cottontails do not burrow, but may use burrows dug by other animals. There are eight genera. They are distributed widely throughout the Holarctic region, where they are highly successful (there are more than 30 species), but are less common in Africa (about eight species) and S. America (two species).

Lepospondyli Group of small Palaeozoic amphibians, distinguished by the possession of vertebrae with spool-shaped centra below the neural arches. The centra were each perforated lengthwise, providing a channel for the notochord. The lepospondylous, or 'husk', vertebra also occurs in living amphibians, but its evolutionary derivation is unclear.

Lepraria Form-genus of imperfect lichens, in which the thallus is powdery and indeterminate. *L. incana* forms pale greenish-grey powdery crusts in damp, shady places, e.g. on tree roots; it is common. *L. candelaris* forms bright, golden-yellow patches on tree trunks, especially in crevices in the bark of oak trees.

leprose Consisting of or bearing powdery or scurfy granules.

leprosy (Hansen's disease) Chronic disease of humans caused by the bacterium *Mycobacterium leprae*. The disease occurs in various forms. There is a very long incubation period and the onset of symptoms is often very gradual. Typically, the nerves are affected and skin becomes anaesthetized; this tends to allow damage of anaesthetized parts and hence leads to mutilation and deformity. *See Mycobacterium*.

Leptanillinae (order Hymenoptera, suborder Apocrita, family Formicidae) Little-known subfamily of tiny, tropical ants, which have reduced eyes, and slender bodies adapted for foraging underground. They are believed to be legionary since the queen is dichthadiiform, as are queens in the Dorylinae. There are about 30 species.

Leptaspis (family Gramineae) Genus of grasses which have broad, ovate leaves. There are five species, occurring in tropical rain forests in W. Africa, the Mascarenes, and from Indo-Malaysia to Fiji.

Leptinotarsa decemlineata (Colorado beetle) *See* Chrysomelidae.

Leptobramidae (beach salmon; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine and brackish-water fish with a deep and compressed body. *Leptobrama muelleri* (beach salmon), 30 cm, has fairly small eyes, a short dorsal fin placed above the anal fin, and a large mouth. It is found only in the coastal waters of New Guinea and tropical Australia.

leptocephalus larva Type of larva found only in certain species of marine bony fish. The appearance of the leptocephalus larva is different from that of the adult. In the case of the eel (*Anguilla*) the larva has a small head with tiny eyes, and the body is shaped like a willow leaf and is virtually transparent; the dorsal and ventral portions of the body divided by the notochord and spinal cord are of approximately the same size. Only after metamorphosis does the fish begin to look like an adult eel.

Leptodactylidae (class Amphibia, order Anura (Salientia), suborder Procoela) Varied family of frogs including arboreal and burrowing forms. Their adaptations to arid conditions include rapid metamorphosis and a capacity to retain water. The family includes *Sminthillus limbatus*, the world's smallest frog (body length 1 cm), but many species are large and voracious. There are about 650 species occurring in Australia, tropical America, and southern Africa.

leptodermous Thin-skinned or thin-walled.

Leptognathina (starfish; subclass Asteroidea, order Spinulosida) Suborder of spinulosan starfish, which possess narrow ambulacral grooves, and small mouth-angle plates. They are known from the Lower Jurassic to Recent.

Leptolinida (class Hydrozoa) Alternative name for the cnidarian order Hydroida.

Leptomedusae Alternative name for the hydroid suborder Calyptoblastina.

Leptopoecile (titwarblers) *See* Regulidae.

Leptoptilos (storks; family Ciconiidae) Genus of large, bare-headed storks which have heavy, straight bills, black wings and upper-parts, and white under-parts. Two species have large, distensible throat pouches. They inhabit open areas often near water, feed mainly on carrion, and nest in trees. There are three species, found in Africa and Asia.

Leptoscopidae (sand fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, with very long dorsal and anal fins which are without spines. The small ventral fins are situated in front of the much larger pectoral fins. Sand fish have a large mouth, with the lower jaw longer than the upper jaw. Found in very shallow water, *Crapatalus arenarius* (9 cm) is able to bury itself quickly in the sand. There are about three species, found in the coastal waters of Australia.

Leptosomatidae (coural, cuckoo-roller; order Coraciiformes) Monotypic family, comprising *Leptosomus discolor*, a large, mainly grey bird. The male has metallic green and purple wings; the female is barred and spotted brown and cream. *L. discolor* has a stout bill, a reversible fourth toe, and a forehead crest which curves forward, partly covering the bill. It inhabits forest and scrub, feeds on insects and lizards, and nests in a tree hole. It is confined to Madagascar and the Comoro Islands.

Leptospermum (family Myrtaceae) Genus of evergreen bushes or small trees whose leaves are small, spiral, and sessile. The flowers are solitary. The fruit is a capsule. There are 50 species, occurring from Malaya to New Zealand and the Caroline

Islands, but most are found in Australia, where they are known as 'tea-trees'.

Leptospira (order Spirochaetales, family Spirochaetaceae) Genus of flexible, spiral-shaped bacteria in which one or both ends of the cells are typically bent or hooked. Aerobic chemo-organotrophs, they may be free-living in aquatic environments, or may be parasitic or pathogenic in vertebrate hosts. Strains of *L. interrogans* can cause Weil's disease (infectious jaundice).

leptospire Pathogenic spirochaete of the genus *Leptospira* which is the causal agent of leptospirosis, a disease affecting many mammals.

leptospirosis Disease of humans and other animals, caused by *Leptospira* species. The disease in humans varies from a relatively mild, feverish condition to a much more severe condition involving jaundice (Weil's disease). Rodents form the main reservoir of infection; rats infected with *Leptospira* excrete the organisms in their urine, so that people who work in rat-infested environments (e.g. sewers) are particularly at risk.

leptosporangiate In vascular plants, applied to the condition in which sporangia have walls comprising a single layer of cells, and arise from a single parent cell. *Compare* eusporangiate.

leptotene *See* meiosis.

Leptothrix Genus of Gram-negative bacteria, not assigned to any taxonomic family. Cells are rod-shaped, occurring in chains enclosed by a sheath, or as single cells or pairs of cells. Sheaths often contain oxides of iron or manganese. Free cells are motile with one or more flagella. They are aerobic chemo-organotrophs. There are at least five species, found in various aquatic habitats, especially in slow-moving, unpolluted, iron-containing streams, etc.

Leptotyphlopidae (slender blind snakes, thread snakes; order Squamata, suborder Serpentes (Ophidia)) Family of snakes which are similar in appearance and habits to the Typhlopidae, but which have teeth only on the lower jaw, and spurs behind the anus (the remnants of hind limbs). There are 40 species, occurring in Africa and tropical America.

lesser cockroach (*Ectobius panzeri*) *See Ectobius*.

lesser grain borer (*Rhyzopertha dominica*) *See* Bostrichidae.

lesser rorqual (minke whale, *Balenoptera acutorostrata*) *See* Balaenopteridae.

lesser spotted catshark (*Scyliorhinus raniculus*) *See* Scyliorhinidae.

lesser stag beetle (*Dorcus parallelipipedus*) *See* Lucanidae.

leste Regional wind affecting N. Africa and Madeira, which blows ahead of a low-pressure area and brings hot, dry conditions.

Lestidae (damselflies; order Odonata, suborder Zygoptera) Ubiquitous family of damselflies, comprising insects which hold their wings partly open when they are at rest. The family is characterized by the fourth branch of the radius, which separates from the radial sector of the wing nearer to the arculus than the nodus. The larvae have elongate labia, and are typically found in vegetation in still water. More than 180 extant species have been described, with a cosmopolitan distribution. *See also* venation.

Lestoideidae (Pseudolestidae, damselflies; order Odonata, suborder Zygoptera) Family of unusual damselflies, which shows many features common to other families, but whose members can be recognized by the reduced first and second anal wing vein, and from the third intercalary, and fourth branch of the radius, arising mid way between the arculus and subnodus in the wing. The larvae are short, with saccoid or lamellar caudal gills. There are 14 described extant species, found in the E. Palaearctic, SE Asia, Australasia, and C. and S. America. *See also* venation.

lethal mutation Gene mutation whose expression results in the premature death of the organism carrying it. Dominant lethals kill heterozygotes, whereas recessive lethals kill homozygotes only. *See also* visibles.

Lethrinidae (emperor; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, tropical fish. Resembling the grunts or sweetlips (Pomadasyidae), the emperors are rather deep-bodied fish with a continuous dorsal fin, a pronounced or pointed snout, scaleless cheeks and strong canine teeth in the jaws. Often brightly coloured, they are good fighters when hooked and are regarded highly by fishermen. Among the largest species is *Lethrinus chrysostomus* (sweetlips emperor), 90 cm, found in the Indo-Australian region. There are about 21 species, found in the Indo-Pacific region and in W. Africa.

Lethrinus chrysostomus (sweetlips emperor) *See* Lethrinidae.

lettuce (*Lactuca sativa*) *See* Compositae.

Leucaena (family Leguminosae, subfamily Mimosoideae) Genus of shrubs or small trees, which have finely-divided, bipinnate leaves. The flowers are axillary, solitary or paired, with 10 stamens. *L. leucocephala* is widely planted as shade for coffee and the like, browse (although if eaten in excess it causes hair to fall out), fuelwood, and timber. There are 50 species, most of which occur in tropical America.

Leucettida (class Calcarea, subclass Calcinea) Order of sponges whose body possesses a sycon or leucon structure. The dermis is present and in some forms a cortex may occur as well.

leucine Aliphatic, non-polar, neutral amino acid. Unlike most amino acids it is sparingly soluble in water.

leucite Mineral, specific gravity 2.5, hardness 5.5–6.0, chemical composition $KAlSi_2O_6$, whose name is derived from the Greek and means 'white'. It occurs in potassium-rich rocks that are poor in silica. It is unstable at high pressures, and therefore tends to occur in lavas. It is distinguished by its crystal form. It is normally white or grey, and has

a vitreous lustre. It crystallizes in the tetragonal system. The crystals form very characteristic tetragonal-trioctahedral grains.

Leucobryum (order Dicranales) Genus of cushion-forming mosses, found mainly in tropical regions. *L. glaucum* is common in Britain; it is a distinctive moss, forming pale, glaucous to greyish-green cushions which become whitish on drying. The leaves can absorb large quantities of water. The cushions are frequently attached only loosely to the ground, and often become detached to form almost spherical moss balls. *Leucobryum* is found in woods and on wet moors; it is calcifuge. The genus contains about 150 species.

leucocyte White blood cell, present in invertebrate and vertebrate animals. There are three types: lymphocytes, amoeboid, non-phagocytic cells that produce or convey antibodies; monocytes, phagocytic cells that ingest invading organisms, sometimes entering tissue to do so; and polymorphs (polymorphonuclear leucocytes, or granulocytes), also phagocytic cells, with granular cytoplasm and lobed nuclei.

leucon Applied to the body structure of a poriferan (sponge) if it is complex and consists of many chambers.

Leuconostoc (family Streptococcaceae) Genus of Gram-positive bacteria in which the cells are spherical or lenticular and usually occur in pairs or chains. Chemo-organotrophic, they can grow in the presence or absence of air. There are several species, found for example in fruit and vegetable matter, and dairy products; none is pathogenic. Some strains are used in the manufacture of certain dairy products, e.g. butter.

Leucophaea maderae (Madeira cockroach) *See* Blaberidae.

leucoplast Colourless plastid involved in the metabolism and storage of starches and oils.

Leucopogon (family Epacridaceae, subfamily Epacrideae) Genus of xeromorphic shrubs with alternate simple sessile leaves with stipules. They have small, regular, bisexual flowers in spikes or racemes, and the fruit is a loculicidal capsule. There are 150 species, mainly represented in Australia but found also in Malaysia and New Zealand.

Leucosolenida (class Calcarea, subclass Calcaronea) Order of sponges whose body possesses an ascon structure.

Leucospidae (suborder Apocrita, superfamily Chalcidoidea) Family of wasps which are similar to the Chalcidae but larger (8–15 mm long) and which have a somewhat hump-backed appearance. The family is sometimes included in the Chalcidae, but its members hold the wings folded longitudinally at rest through the retention of wing coupling. Adults are brightly coloured black and yellow, and the females have a curved ovipositor which lies anteriad (pointing forward) along the dorsal surface of the abdomen. Leucospids are usually found on flowers and are parasitic on various species of wasp and bee.

Leucotrichaceae (Order Cytophagales) Family of bacteria, which form long filaments with cross-walls. The filaments are usually attached to a solid substrate and do not glide; they release single cells (gonidia) which may be capable of gliding motility. Leucotrichaceae are aerobic and found in marine or freshwater habitats.

leukoviruses Old term for certain oncogenic RNA-containing viruses that are now included in the Retroviridae.

Leuresthes tenuis (California grunion) *See* Atherinidae.

levanter Local wind from the east experienced in the Straits of Gibraltar and associated with standing waves in the lee of the Rock of Gibraltar. The wind is especially prevalent in late summer and autumn and brings high humidity.

leveche Local wind affecting SE Spain, especially in summer, and similar to such other hot, dry, dusty winds of tropical continental origin as the scirocco and khamsin, which blow in the Mediterranean region.

levée Raised embankment of a river, showing a gentle slope away from the channel. It results from periodic overbank flooding when coarser sediment is immediately deposited due to a reduction in velocity. This may lead to a situation in which the river flows well above the level of its outer floodplain.

levulose *See* fructose.

Leycesteria (family Caprifoliaceae) Genus of deciduous shrubs with flowers in whorls in axils of bracts, forming drooping terminal spikes. The flowers are regular, pentamerous, and funnel-shaped. They are cultivated for ornament. There are six species occurring in Himalayan and Chinese mountains.

LH *See* luteinizing hormone.

liana *See* liane.

liane (liana) Wiry or woody, free-hanging, climbing plant.

Lias Commonly-used term for the lowest stage of the Jurassic. The Liassic is synonymous with the Hettangian/Sinemurian Stages of Europe. Blue-grey shales and muddy limestones are typical of the Lias, with *Dactylioceras* and *Gryphaea* among the more important fossils found in the extensive outcrops of England and France.

libeccio Local south-westerly wind which brings stormy conditions, especially in winter, to the central Mediterranean.

Libellula depressa (broad-bodied chaser) *See* Libellulidae.

Libellulidae (dragonflies; order Odonata, suborder Anisoptera) Ubiquitous family of dragonflies, of most recent and tropical origin, which contains about one-quarter of all the known species of living Odonata. These dragonflies are usually colourful, and are seen frequenting bodies of still water. The anal angle of the hindwing is always rounded, and there is a foot-shaped anal loop. The short, stout nymphs are found mainly in still water, where they

hunt in the bottom mud. There are about 3750 species, with a cosmopolitan distribution. *Libellula depressa* (broad-bodied chaser) is a broad-bodied dragonfly in which the males have blue pruinosity on the abdomen, while females are brown. Both sexes have a row of yellow spots down the sides of the abdomen. Males are very territorial, often making sallies from a prominent perch. They are found throughout Europe and the Middle East. *See also* venation.

Libocedrus (incense cedars; family Cupressaceae, tribe Cupressinae) Genus of trees with leafy branches compressed on two sides and bearing scale-like leaves in opposite pairs; the cones are oblong with elongate valvate scales, of which only one pair is fertile; the seeds are unringed. The leaves, rich in resin, smell of turpentine when crushed. There are nine species occurring in N. and S. America, E. Asia, and New Zealand.

Libytheidae (snout butterflies; order Lepidoptera) Small family of butterflies in which the palps project from the front of the head like a 'snout'. They have small, angular forewings. The forelegs of males are reduced, but in females they are fully developed. They are closely related to the Lycaenidae, and sometimes treated as a subfamily of the Riodinidae. They are distributed worldwide.

Licania (family Chrysobalanaceae) Genus of small, evergreen, rainforest trees whose fruit is a drupe, and which yield useful but siliceous timber. There are 150 species, 149 found in tropical America, and one in W. Malesia.

lice *See* Phthiraptera.

lichen Type of 'composite organism', which consists of a fungus (the mycobiont) and an alga or cyanobacterium (the phycobiont) living in symbiotic association. A lichen thallus may be crust-like, scaly, leafy, or shrubby, according to the species. In the majority of lichens the fungal partner belongs to the Ascomycotina, and many lichens produce ascocarps which are important in classification. Asexual reproductive structures may also be produced (*see* for example, soredium; and isidium). Many lichens are extremely sensitive to atmospheric pollution and have been used as pollution indicators.

Lichenes Imperfecti Category of lichens in which no sexual reproductive structures have ever been found. These lichens are placed in form-genera on the basis of vegetative characteristics.

lichenicolous Growing on lichens.

lichenin Glucan found in lichens, containing 80–200 beta-glucose units. Of these, about 30% are glycosidically linked to the third carbon atom, and the remainder to the fourth carbon atom of the neighbouring sugar units.

lichen wood Facies of the boreal conifer zone, situated south of the forest-tundra ecotone and north of the closed forest proper. The characteristic is that of open woodland, with a sparse stand of conifers set in a ground layer dominated by lichens, e.g. *Cladonia*.

lichen zone Area with a characteristic lichen flora ranging from complete absence to a full complement of foliose and fruticose species, depending on the level and type of air pollution present in the area. The standardized lichen zones for England and Wales range from zone 0 (complete absence) typical of heavily polluted industrial areas, to zone 10 in which bearded lichens (e.g. *Usnea* and *Ramalina* species) are present in association with many other species. Zone 10 is typical of unpolluted areas in which virtually no sulphur dioxide, fluorine compounds, or other air pollutants are present.

lichi *See Litchi*.

Lichinaceae (order Lecanorales) Family of lichens in which the phycobiont is a cyanobacterium (blue-green alga). The thallus is more or less gelatinous and is typically dark to black in colour. There are many genera, most of which are found on stones, frequently in wet habitats. *Lichina confinis* and *L. pygmaea* form tiny fruticose thalli and are common on rocks by the sea at or below high-water mark.

Licuala (family Palmae) Genus of small fan palms, of forest undergrowth, which are sometimes stemless, and often clumped. Leaflets have multiple folds, and are blunt. The inflorescences are held as axillary panicles. The flowers are hermaphrodite with three free carpels. The fruits are brightly coloured, and thinly fleshy. There are about 100 species, found from S. China and Burma to Queensland and Tuvalu.

Lidth's jay (*Garrulus lidthi*) *See Garrulus*.

Liebig, Baron Justus von (1803–73) German chemist who contributed much to the systematization of organic chemistry, to the early development of biochemistry, and to agricultural chemistry. In 1840 he published *Die organische Chemie in ihrer Anwendung auf Agrikulturchemie und Physiologie* ('Organic chemistry in its application to agricultural chemistry and physiology'), in which he showed that plants take up nutrients in simple chemical form and that nutrient deficiencies in soils may be remedied by the application of mineral fertilizers. He maintained that plant growth is limited by the availability of the scarcest essential nutrient (his law of the minimum). Others expanded on this work later to produce a broader appreciation of the 'limits of tolerance', recognizing that maximum as well as minimum thresholds exist for all commodities (not only chemicals) that are essential to plant and animal growth. *See also* Shelford's law of tolerance.

Liebig's law of the minimum Concept first stated by J. von Liebig (1840) that the rate of growth of a plant, the size to which it grows, and its overall health depend on the amount of the scarcest of its essential nutrients that is available to it. This concept is now broadened into a general model of limiting factors for all organisms, including the limiting effects of excesses of chemical nutrients and other environmental factors. *See also* Shelford's law of tolerance.

life State of physical entities that utilize substances derived from outside themselves for the purposes

of growth, the repair of their own structure, and the maintenance of their functional systems, and that reproduce. The oldest known fossils are from rocks about 3300 million years old, and the Earth is estimated to be about 4600 million years old. If it is accepted that life began on Earth (rather than being introduced from elsewhere), then it must have done so during the intervening 1300 million years. There is disagreement on the mechanism by which this happened. The classic view is that lightning discharges in a reducing atmosphere produced prebiotic substances which became dissolved in the oceans where, protected from ultraviolet light, they were somehow assembled into the first organisms. Recently evidence has been advanced that suggests that life may have originated in small freshwater pools in an atmosphere of carbon dioxide with just traces of ammonia.

life cycle Series of developmental changes undergone by the individuals comprising a population, including fertilization, reproduction, and the death of those individuals and their replacement by a new generation. The life 'cycle' in fact is linear with respect to individuals, but cyclical with respect to populations. In many animals and plants there is a succession of individuals in the entire cycle with sexual or asexual production linking them. In vertebrates, the life cycle is confined to the period from fusing of the gametes to the death of the resulting individuals.

life-form The structure, form, habits, and life history of an organism. In plants, especially, characteristic life-forms, in particular morphological features, are associated with different environments. This observation has formed the basis of several attempts at life-form classifications of vegetation. Raunkiaer's scheme (1934) is the best-known and most widely applied life-form scheme. *See also* Raunkiaer, C.

life-zone Original concept of C. H. Merriam (1894) describing the way in which changing vegetation forms give a series of life-zones in relation to temperature gradients. In modern ecology these life-zones are defined by reference to a range of interacting environment gradients, and reflect animal as well as plant characteristics. On a world scale life-zones are thus synonymous with the major biomes. However, 'life-zone' is more frequently used for more local changes, e.g. the altitudinal zonation of communities on mountains.

lifting condensation level Level at which air becomes saturated when forced to rise. (The level can be determined on a tephigram, where a dry adiabat line intersects a line of saturation mixing ratio through the dew-point temperature.)

ligand Atom, ion, or molecule that acts as the electron-donor partner in one or more co-ordination bonds. A heterocyclic ring is formed if the ligand is an organic compound, and the product is termed a chelate.

ligase Enzyme that catalyses a reaction that joins two substrates, using energy derived from the simultaneous hydrolysis of a nucleotide triphosphate.

light-and-dark bottle technique *See* oxygen method.

lightning beetle *See* Lampyridae.

Ligia oceania (order Isopoda, family Ligiidae) Species of isopods which are common on coasts, where they run rapidly over the substrate and beneath stones. Males grow up to 28 mm long and females up to 20 mm. The body has a rough texture, and is oval, flattened, and grey-greenish with paler dots and markings. The eyes are black. Males have seven pairs of legs, females six pairs. The isopods feed nocturnally, preferring the seaweed *Fucus* (wrack). The species occurs in N. Europe but has also been reported several times from the New England coast.

Ligiidae (rock slaters, sea slaters; subclass Malacostraca, order Isopoda) Family of isopods whose members live in middle- and upper-shore regions, hiding during the day in cracks and crevices (e.g. in harbour walls), and beneath stones and seaweed. They are particularly active at night, can run fast when disturbed, and are widely distributed and abundant.

lignicolous Growing on decorticate wood.

lignin Complex cross-linked polymer comprising phenylpropanoid units found in many plant-cell walls. Its function appears to be to cement together and anchor cellulose fibres and to stiffen the cell wall.

lignite *See* coal.

lignum vitae (timber of *Guaiacum officinale*) *See* Zygophyllaceae.

ligulate Strap-like or tongue-shaped; having ligules.

lilac *See Syringa*.

Liliaceae Large family of monocotyledons, mostly herbs with elongated leaves springing from rhizomes, corms, or bulbs, but some are shrubs or trees. The leaves may be all from the base, or alternate up the stem, or whorled. The inflorescence is a raceme or umbel, the flowers mostly regular and trimerous, with two usually similar whorls of petaloid perianth segments; there are usually six stamens, the ovary is superior; and is normally three-celled. The fruits are capsules or berries. Many (e.g. *Lilium* and *Tulipa*) are cultivated for their flowers; others as vegetables or for flavouring (e.g. *Allium*, onions and garlic). There are about 200 genera, comprising 2500 species, with a cosmopolitan distribution.

Lilium (lily; family Liliaceae) Genus much cultivated for the flowers, which are in racemes on leafy stems and have six recurved perianth segments. There are some 90 species, occurring in the northern temperate zone.

lily *See Lilium*.

lily-of-the-valley *See Convallaria*.

limb borer *See* Bostrichidae.

lime 1 (*Citrus aurantifolia*) *See Citrus*. 2 (linden) *See Tilia*. 3 Compounds mostly of calcium carbonates,

but also other basic (alkaline) substances, used to correct soil acidity and occasionally as a fertilizer to supply magnesium.

Limes convergens Well-defined boundary zone between two fairly uniform major habitat types. An example is a flood meadow zone, which is subject to periodic catastrophic flooding: this includes species characteristic of wet conditions, as well as those typical of trampled and grazed areas (which reflect the normal use when the area is not flooded).

Limes divergens Diffuse boundary zone in which one major habitat type changes gradually into another, typically with both types showing internal variation. It is more stable than the Limes convergens, since the change in environment is spatially and temporally gradual and persistent, rather than catastrophic and/or intermittent.

limestone Sedimentary type of rock composed mainly of calcite and/or dolomite, which is often of organic, chemical, or detrital origin. *See also* carbonates.

limestone forest Distinctive forest type, found within tropical rainforest regions of SE Asia, and also in the Caribbean region, growing over limestone hills (karst). There are a few endemic genera, e.g. the palms *Liberbaileya* and *Maxburretia*, which are restricted to limestone forests in Malaysia.

limestone pavement *See* clint.

limiting factor (ecological factor) Defined originally as whichever essential material is available in an amount most closely approaching the critical minimum needed, but now used more generally to describe any environmental condition or set of conditions that approaches most nearly the limits (maximum or minimum) of tolerance for a given organism.

limits of tolerance The upper and lower limits to the range of particular environmental factors (e.g. light, temperature, availability of water) within which an organism can survive. Organisms with a wide range of tolerance are usually distributed widely, while those with a narrow range have a more restricted distribution. *See also* Shelford's law of tolerance.

limnetic zone The area in more extensive and deeper freshwater ecosystems that lies above the compensation level and beyond the littoral (lake-edge) zone. This zone is mainly inhabited by plankton and nekton with occasion neuston species. The limnetic and littoral zones together comprise the euphotic or well-illuminated zone. In very small and shallow lakes or ponds the limnetic zone may be absent.

limnology The study of freshwater ecosystems, especially lakes.

limonite Mineral, specific gravity 3.3–4.0, hardness less than 4, chemical composition $HFeO_2.nH_2O$, whose name is derived from the Greek for 'lemon'. It is a secondary mineral due to the breakdown of other iron minerals, especially in the zone of oxidation, and is formed extensively as brown ores in marine and lacustrine basins. It is normally dark brown to yellow-brown, and has a light brown to yellow-brown streak. It crystallizes in the orthorhombic system. There are usually no crystals, and it forms earthy masses, incrustations, and replacement masses.

Limonium vulgare (common sea lavender) *See* polyhaline.

Limosa (godwits; family Scolopacidae) Genus of large wading birds which have long legs, and long, straight or slightly upcurved bills. Two species have black and white patterned wings and tail. There are four species, breeding in arctic regions of N. America, Europe, and Asia, and migrating to S. America, S. Europe, Africa, S. Asia, and Australia.

limpet (*Patella vulgata*) *See* Archaeogastropoda.

limpkin (*Aramus guarauna*) *See* Aramidae.

Linaceae Family of herbs, shrubs, and trees with regular penta- or tetramerous flowers and the same number of sepals, petals, and stamens; the ovary is 3–5-celled, the fruit a capsule. They are cultivated for flowers or useful products, e.g. *Linum* species yield flax and linseed oil. Modern classifications recognize some 270 species, within 14 genera.

Lincoln index Simple estimate of animal population density, based on mark–recapture data. *See* mark–recapture techniques.

Lindeman's efficiency Ratio of energy assimilated at one trophic level to that assimilated at the preceding trophic level; the ratio of energy intake at successive trophic levels. It is one of the earliest and most widely applied measures of ecological efficiency.

linden *See Tilia*.

lineage *See* evolutionary lineage.

linear sand ridge Submarine sand mound typical of shallow sea and wide continental-shelf areas, 3–10 m high, 1–2 km wide, which may extend for tens of kilometres across the shelf and have an average spacing of about 3 km. Such ridges have been described from the North Sea (off Norfolk, England) and the eastern seaboard of the USA. They are the product of storm and tidal action.

lineation (geol.) Any linear feature that appears on a surface and that may be formed by an alignment of fossils, minerals, or structural features.

line squall Stormy conditions, with sudden changes of wind and with heavy cloud, often involving thunderstorms, and a temperature fall; often associated with the passage of a cold front: it defines the line of the cloud and wind structure. Warm air is overrun by cold air to produce the squall line.

ling 1 *See Calluna*. 2 (*Molva molva*) *See* Gadidae.

lingcod (*Ophiodon elongatus*) *See* Hexagrammidae.

lingual Of the tongue.

Lingulacea (order Lingulida) Superfamily of inarticulate brachiopods with phosphatic shells. The pedicle valve, bearing the pedicle groove, is usually larger than the brachial valve. Lingulacea appeared in the Lower Cambrian.

Lingulella viridis One of the earliest recorded inarticulate brachiopods, and very similar to extant species of the genus *Lingula*. *L. viridis* is described from the Lower Cambrian of England. It is one of several species referred to the cosmopolitan genus *Lingulella*.

Lingulida (class Inarticulata) Order of Brachiopoda, with valves of calcium phosphate with some layers of organic material. The valves may be finely punctate or impunctate. The pedicle emerges between the valves posteriorly. Lingulida are usually marine, but some are tolerant of reduced salinity. They appeared first in the Lower Cambrian. There are two superfamilies, comprising eight families, and about 50 genera.

Liniphiidae (money spiders; order Araneae, suborder Araneomorphae) Family of small, uniformly black or brown spiders which construct sheet webs among vegetation. The webs do not have a retreat, as do those constructed by the Agelenidae; the adult spider hangs on the under-side of the web and runs over it to catch prey. The chelicerae have many teeth, and the legs bear many strong setae. The members of this large family are among the commonest and most abundant species in the northern hemisphere, 40% of the British spider fauna belonging to the family. Many species travel long distances by 'ballooning' on long threads of silk.

linkage The association of genes that results from their being on the same chromosome. Linkage is detected by the greater association in inheritance of two or more non-allelic genes than would be expected from independent assortment. The nearer such genes are to each other on a chromosome, the more closely linked they are, and the less often they are likely to be separated in future generations by crossing-over. All the genes in one chromosome form one linkage group.

linkage disequilibrium In genetics, the continued association of characters known to be determined by separate genes. Such genes are said to be co-adapted with the others with which they are associated. In natural populations, linkage disequilibrium is observed as unusually small or zero recombination frequencies; it is most common between loci already known to be closely linked. A likely explanation is that a section of the chromosome has been inverted and/or translocated, making this section (and perhaps some other section) non-homologous with the sister chromosome of the pair. Recombination is thus precluded, and genes along this section behave as a single 'supergene'.

linkage map Abstract map of chromosomal loci, based on experimentally-determined recombinant frequencies, which shows the relative positions of the known genes on the chromosomes of a particular species. The more frequently two given characters recombine, the further apart are the genes that determine them.

Linognathidae (order Phthiraptera, suborder Anoplura) Family of sucking lice which are parasitic on members of the mammalian orders Artiodactyla, Perissodactyla, Carnivora, and Hyracoidea. Like Haematopinidae, these lice lack eyes, but they also lack the prominent ocular points characteristic of the other family. The family comprises 69 species, in three genera of which one, *Prolinognathus*, is sometimes placed in its own family. This genus contains all the species of Anoplura parasitic on hyraxes, other lice found on hyraxes belonging to the Ischnocera (family Trichodectidae).

linoleic acid Polyunsaturated fatty acid containing two double bonds and comprising 18 carbon atoms. It is classed as an essential fatty acid since it is required by mammals but cannot be synthesized by them. It is a precursor of prostaglandins.

Linophrynidae (monster anglerfish; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of deep-sea anglerfish with a bizarre appearance. They have a short and almost round body, a very large mouth with needle-like teeth, and a strongly developed illicium ('fishing rod') above the snout. The fins are small, with the exception of the larger, rounded tail-fin. Females may possess a long tassel-like or branching barbel under the chin. The mature male is tiny and remains attached to the body of the female until spawning. There are about 20 species, distributed worldwide.

linseed oil *See Linum*.

Linum (family Linaceae) Genus of herbs with narrow, linear, sessile leaves, and cymose inflorescences along the stems. The flowers have five-clawed petals that soon fall, and globular 10-valved capsules. Some species are grown for ornament, for the fibres (flax), or for the oil in the seeds (linseed oil). There are some 200 species, mostly in temperate and subtropical parts of the northern hemisphere.

lion (*Panthera leo*) *See Panthera*.

lionfish (*Pterois volitans*) *See* Scorpaenidae.

Liopempheris multiradiata (common bullseye) *See* Pempheridae.

Liphistiidae (order Araneae, suborder Mesothelae) Family of spiders which have the normal carapace covering the prosoma, but in which the abdomen is distinctive in being clearly segmented. The spiders are 1–3.5 cm long, and have two pairs of book lungs. They sit in tubes up to 60 cm deep, dug out from the substrate, and use their chelicerae to hold shut a trapdoor. A few radial threads spread out from the tube to trip prey items and alert the concealed spider. The family occurs from SE Asia to S. Japan.

lipid Member of a heterogeneous group of small organic molecules that are sparingly soluble in water, but soluble in organic solvents. Included in this classification are fats, oils, waxes, terpenes, and steroids. The functions of lipids are equally diverse and include roles as energy-storage compounds, as hormones, as vitamins, and as structural components of cells, particularly membranes.

lipofucsin Dark pigment that occurs in older animal cells and is often termed 'age pigment'.

lipoic acid (6,8-dithio-*n*-octanoic acid) Compound that functions as a coenzyme in the oxidative decarboxylation of pyruvic acid to alpha-ketoglutaric acid and of the latter to succinic acid. It is sometimes classed as a vitamin as it is an essential requirement for some micro-organisms.

lipoprotein Water-soluble, conjugated protein in which the prosthetic group is a lipid.

Lipotyphla (cohort Unguiculata, order Insectivora) Suborder (or full order) that includes most extant insectivores, grouped into two superfamilies, Erinaceoidea, the hedgehogs and moon rat, and Soricoidea, the shrews and moles. Most are small, nocturnal animals showing many features, especially of the skull and teeth, similar to those of early fossil eutherians, for which reason the insectivores are held to be evolutionarily primitive.

Liquidambar (family Hamamelidaceae) Small genus of trees and shrubs, which have maple-like leaves. Male flowers are held in spikes, female flowers in heads. *L. styraciflua* (sweet gum) has superb autumn colours and provides the timbers American red gum (heartwood) and American sap gum (sapwood). They occur in temperate areas of western N. America, Asia Minor, and E. Asia.

liquid limit *See* Atterberg limits.

lirella Elongated, slit-like, sometimes branching ascocarps formed by lichens of the family Graphidaceae.

Liriodendron (family Magnoliaceae) Genus of trees whose leaves have a curiously truncate or bilobed apex. There are two species: *L. tulipifera* (tulip tree), which provides the timber American whitewood, occurs in eastern N. America; and the other species occurs in E. Asia. They have now been hybridized.

Lissamphibia *See* Urodela.

listroceline grasshoppers *See* Tettigoniidae.

Litchi (lichi, lychee; family Sapindaceae) Genus of small trees, closely related to *Nephelium* and producing a similar edible arillate fruit, but in which the pericarp is smooth. They are native to China, and cultivated in warm-temperate climates.

Lithisida (class Demospongiae, subclass Tetractinellida) Order of sponges which possess bulky, intertwined spicules of silica. The order is rather artificial, containing members from several orders with this type of skeleton. They are found mainly in deep water below the photic zone. They are first recorded from the Cambrian.

litho- Prefix: pertaining to rock or stone.

lithofacies Rock noted for a distinctive group of characteristics, e.g. composition and grain size.

Lithocarpus (family Fagaceae) Genus of trees, related to the oaks (*Quercus*) and similar in their acorns, bark, and wood with broad rays, but which produce bisexual inflorescences. The timber is used mainly for firewood because it is difficult to work. There are 300 species, found in the tropics and subtropics from India to Japan and Malesia, plus one species in western N. America.

lithology Term commonly applied to the macroscopic features of sedimentary rocks, e.g. their texture or petrology.

Lithorhizostomatida (subclass Scyphomedusae) Fossil order of medusae, known only from the Upper Triassic of Solnhofen, Germany. They resemble Rhizostomatida, but have a cruciform mouth not covered by oral arms.

lithosere Sequence of plant communities, proceeding through all the stages of a succession to a climax vegetation, and that begins on a bare rock surface. *See* succession.

lithosphere The outer, rigid part of the Earth's crust, including the continental and oceanic crust and the upper part of the mantle, and that part of the surface of the planet that is derived from rock, in contrast to the hydrosphere and atmosphere. The lithosphere is approximately 80 km thick under the oceans and 100–150 km thick beneath the continents.

lithostratigraphy Branch of stratigraphy concerned with the description of rock units in terms of their lithological features. It deals with the spatial relations of such rock units, but does not take into consideration (a) the evolution of the organisms contained within the units (biostratigraphy), or (b) geological time (chronostratigraphy).

lithotroph Organism that obtains energy from the oxidation of inorganic compounds or elements (*compare* organotroph). Sometimes the term is inaccurately used as a synonym of 'autotroph'.

litmus Dye obtained from lichens of the genus *Roccella*. Litmus is used as a pH indicator, being red under acidic conditions and blue under alkaline conditions.

Litopterna (cohort Ferungulata, superorder Protoungulata) Extinct order of S. American ungulates which lived from the Eocene to the Pleistocene, and which are considered to be descendants of the condylarths. They were hoofed, and the central metapodials became elongated and the lateral ones reduced to leave three toes and, in *Thoatherium*, one. The incisors were reduced in some forms, but in most dentition was complete. One line developed remarkable 'pseudo-horses', e.g. *Diadiaphorus* and *Thoatherium*, which strongly resembled their perissodactyl contemporaries. The other major lineage culminated in *Macrauchenia*, which strongly resembled the N. American camels, apart from the possible presence of a short, tapir-like trunk. From the presence of a nasal opening on the top of the skull, however, other authorities have inferred that *Macrauchenia* followed a life in water, rather than one that involved a trunk.

Litsea (family Lauraceae) Genus of evergreen trees in which the leaves are alternate, and the inflorescence is subtended by an involucre. The fruit is inserted in the calyx tube. The genus provides many traditional medicines. There are 400 species, found in warm-temperate, subtropical, and tropical regions.

litter (L-layer) Accumulation of dead plant remains on the soil surface.

little auk (*Alle alle*) *See Alle*.

little earwig (*Labia minor*) *See* Labiidae.

littoral fish Freshwater littoral fish are those found along the shores of a lake from the edge of the water down to the limits of rooted vegetation. Marine littoral fish are those found in the intertidal zone of the sea shore, most of the fish moving in and out with the tide.

littoral fringe The uppermost reaches of the littoral zone of marine ecosystems. On rocky shores it is the main area for *Littorina* species (periwinkles), and the black lichen, *Verrucaria*, and is distinguished from the lower, eulittoral zone by the absence of barnacles, e.g. *Balanus* species and *Chthamalus* species. On sandy shores crabs, beach amphipods, and some land insects are characteristic.

littoral zone 1 The area in shallow fresh water and around lake shores where light penetration extends to the bottom sediments, giving a zone colonized by rooted plants. 2 In marine ecosystems the shore-area or intertidal zone where periodic exposure and submersion by tides is normal. Since the precise physical limits of tidal range vary constantly a biological definition of this zone, which essentially reflects typical physical conditions rather than rarely experienced events, is generally more useful. Thus in Britain the littoral zone is defined as the region between the upper limit of species of the seaweed *Laminaria*, and the upper limit of *Littorina* species (periwinkles), or of the lichen *Verrucaria*.

live-bearing fish Fish in which the fertilized eggs are retained initially within the body of the female, but are subsequently released as newly-hatched larvae (e.g. some Scorpaenidae) or born as free-swimming postlarvae in which the yolk has been fully utilized and the yolk sac has disappeared (e.g. some sharks, and Poeciliidae).

liver In vertebrates, a large gland, richly supplied with blood, that arises from the intestine. It is concerned with the filtering of blood; with the storage of sugars, vitamins, and other food substances; with aiding digestion; with the production of proteins and antibodies; and with the removal of wastes.

liverwort (hepatic) Common name for a plant belonging to the class Hepaticae.

Livistona (family Palmae) Genus of tall, solitary fan palms which have fibrous leaf sheaths. The inflorescence is a hanging panicle. The flowers are hermaphrodite, with three carpels, united at the styles; and the stigma is basal. There is one fleshy, brightly coloured fruit to each flower, containing a seed with a thin stone. There are 28 species, found from Assam and S. China to the Solomon Islands (where there is one species), and Australia (12 species).

lizard *See* Lacertidae; and Sauria.

lizardfish *See* Synodontidae.

llama (*Lama glama*) *See* Camelidae.

llanos Savannah grasslands of the Orinoco basin of Venezuela. Some authorities have suggested that the paucity of trees is due to the heavy subsoil of the region, which produces very wet conditions during the rainy season. It is more likely, however, that fire and grazing are responsible for preventing the development of woodland.

L-layer *See* litter.

loach goby *See* Rhyacichthyidae.

loam Class of soil texture composed of sand, silt, and clay, which produces a physical property intermediate between the extremes of the three components.

Lobaria (family Lobariaceae) Genus of lichens in which the thallus is foliose, often large, with short, felt-like hairs on the lower surface. The phycobiont may be a green alga or a cyanobacterium, according to the species. Spores are colourless or pale brown, fusiform to elongated, with one to many septa. *Lobaria* is found chiefly in moist districts (in Britain in the west) on trees or occasionally on rocks.

Lobariaceae (order Lecanorales) Family of lichens in which the thallus is foliose and often large; the lower surface typically bears pores (e.g. cyphellae or pseudocyphellae). The phycobiont may be a green alga or a cyanobacterium (*Nostoc*). Spores are transversely septate with one to many septa. There are three genera, found in humid regions on various types of substrate.

Lobata (class Tentaculata) Order of ctenophorids which have laterally compressed bodies. The two main tentacles are generally absent in mature forms. Small lateral tentacles are present.

lobed spinifex (*Triodia basedowii*) *See Triodia*.

Lobelia (family Lobeliaceae) Genus comprising mainly herbs, and some shrubs. The flowers, in leaf axils or in racemes, have two-lipped corollas split down the back, and beards on some anthers. The fruit is a capsule. There are some 250 species, throughout most tropical and temperate areas of the world. The genus shows an extraordinary degree of endemism in the E. African mountains, where many species with huge columnar inflorescences occur, each mountain block tending to have one or more endemic species in the alpine zones.

Lobeliaceae Family of herbs or small trees, mainly tropical but with some temperate species, close to Campanulaceae, but with irregular two-lipped corollas. Many, e.g. *Lobelia*, are grown for ornament. Modern classifications recognize about 25 genera, with 400 species.

lobopodium Type of pseudopodium which is broad with a blunt, rounded tip.

Lobotidae (tripletail; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish with a large and heavy body. The rounded dorsal, anal, and tail fins of similar size are characteristic, and give the fish the appearance of having a tri-lobed tail. The best-known species is *Lobotes surinamensis* (1 m), a sluggish fish found in coastal waters of tropical seas. Probably it is a cosmopolitan species. There are about four species, with some SE Asian species found in brackish-water or freshwater habitats.

lobsters 1 *See* Crustacea; Decapoda; and Nephropidae. 2 (common (European) lobster) *See Homarus gammarus*. 3 (Dublin Bay prawn) *See Nephrops norvegicus*. 4 (giant American lobster) *See Homarus americanus*. 5 (giant spiny lobster) *See Jassus heugeli*. 6 (Norway lobster) *See Nephrops norvegicus*. 7 (scampi) *See Nephrops norvegicus*. 8 (spiny lobsters) *See* Palinuridae.

local wind Air movements, generally of limited geographical range, characteristic of a particular region and/or area of particular land and atmospheric configuration. Many local winds are especially associated with orographic peculiarities or with particular high- or low-pressure systems, and local names may be applied to winds of a broad, general type. Examples include the föhn winds, of orographic origin, and the many regional winds of the Mediterranean area, whose origins lie in the tropical continental air masses of the Sahara.

lochan *See* knock and lochan.

Loch Lomond Stadial Relatively cold period that occurred towards the end of the last (Devensian) glaciation in Scotland. The event took place about 11 000–10 000 radiocarbon years BP. It is characterized by the development of small ice caps and cirque glaciers in the Highlands.

loci *See* locus.

lock-and-key theory Theory to explain the mechanism of enzymatic reactions, in which it is proposed that the enzyme and substrate(s) bind temporarily to form an enzyme–substrate complex. The binding site on the enzyme is known as the 'active site' and is structurally complementary to the substrate(s). Thus the enzyme and substrate(s) are said to fit together as do a lock and a key.

lockjaw *See* tetanus.

locule Cavity of the ovary. *See* carpel.

loculicidal Of a seed-bearing pod, splitting longitudinally along the mid-rib.

Loculoascomycetes (subdivision Ascomycotina) Class of fungi, in which the fruiting body is an ascostroma and the asci are bitunicate. There are five orders. They are saprotrophs (found on plant debris, wood, dung, etc.) or parasites (on plants, fungi, or insects).

locus (pl. loci) Specific place on a chromosome where a gene is located. In diploids, loci pair during meiosis and unless there have been translocations, inversions, etc., the homologous chromosomes contain identical sets of loci in the same linear order. At each locus is one gene; if that gene can take several forms (alleles), only one of these will be present at a given locus.

locust 1 (class Insecta, order Orthoptera, family Acrididae) Name given to several species of acridids which show density-related changes in their morphology and behaviour. At low population densities the insects develop as solitary, cryptically coloured grasshoppers (phase *solitaria*). At higher densities, such as may result from an abundance of food after rain, the insects develop into gregarious, brightly coloured individuals, which swarm and migrate, often causing great destruction to vegetation (phase *gregaria*). Major species include *Locusta migratoria* (migratory locust); *Schistocerca gregaria* (desert locust), and *Nomadacris septemfasciata* (red locust). 2 (carob) *See Ceratonia*.

Locusta migratoria (migratory locust) *See* locust.

Locustella (grasshopper warblers; family Sylviidae) Genus of brown, often streaked warblers which have long under-tail coverts, and a graduated tail. They are secretive and skulking, almost terrestrial, and found in scrub, reedbeds, and grassland; they feed on insects; and they build their nests low in grass or reeds. Many have a characteristic, sustained song, particularly *L. naevia* (grasshopper warbler). There are nine migratory species, found in Europe, Africa, and Asia.

lodgement till *See* till.

lodgepole pine *See Pinus contorta*.

lodging In plants, a state of permanent displacement of a stem-crop stem from its upright position. This can cause considerable reduction in yield. Normally it is caused by storm damage, but may be due to rots, insects or excess nitrogen.

Lodoicea (double coconut; family Palmae) Monotypic palm genus (*L. maldivica*), endemic to the Seychelles, and rare in the wild, often cultivated. It is a huge fan palm, with a trunk up to 30 m tall, and leaves 3 m or more long. It is dioecious. The inflorescences are unbranched, emerging through split leaf bases. Female flowers are 5 cm across. The fruit is like a huge bilobed coconut 45 cm long, weighing 14–22 kg, and containing one giant seed with a stony wall, the biggest seed in the world.

loess Unconsolidated, wind-deposited sediment composed largely of silt-sized quartz particles (0.015–0.05 mm diameter) and showing little or no stratification. It occurs widely in the central USA, N. Europe, Russia, China, and Argentina. It can give rise to a rugged topography with steep slopes (up to 70°).

log Piece of timber, of any length, but of the full diameter of the tree from which it came.

Logania (family Loganiaceae, tribe Loganieae) Genus of small trees and shrubs. It has opposite entire leaves, phloem tubes scattered through the xylem, and superficial cork development. The flowers are regular in terminal cymes; the fruit is a capsule or berry. The seeds have a fleshy endosperm. There are 25 species, mainly restricted to Australia and New Zealand where the shrubs are often present as an understorey in *Eucalyptus* forest.

Loganiaceae Family of trees, shrubs, and climbers, in which the leaves are simple, opposite, and often with stipules. The flowers are hermaphrodite and regular, with four or five fused sepals and petals with imbricate lobes, four or five epipetalous stamens, and a superior ovary with two locules. The fruit is a capsule. Many species contain poisonous alkaloids, some of which are medicinal. There are 30 genera, with 600 species, occurring in temperate, subtropical, and tropical regions.

loggerhead turtle *See Caretta caretta*.

logistic equation (logistic model) Mathematical description of growth rates for a simple population in a confined space with limited resources. The equation summarizes the interaction of biotic potential with environmental resources, as seen in populations showing the S-shaped growth curve, as: $dN/dt = rN(N-K)/k$ where N is the number of individuals in the population, t is time, r is the biotic potential of the organism concerned, and K is the saturation value or carrying capacity for that organism in that environment. The resulting growth rate or logistic curve is a parabola, while the graph for organism numbers over time is sigmoidal. *Compare* J-shaped growth curve.

logistic model *See* logistic equation.

logwood (*Haematoxylum campechianum*) *See Haematoxylum*.

Lomandra (family Xanthorrhoeaceae) Genus of woody rhizomatous perennials with tall stems, simple linear sheathing leaves, and regular flowers, often rigid and coloured. The plants are dioecious. There are 40 species, found in Australia, New Zealand, and New Guinea.

Lonchura (mannikins, munias, silverbills; family Estrildidae) Genus of small, finch-like, buff, chestnut, black, grey, and white birds, which have short to medium-length, pointed tails, and stout, often silver-coloured bills. They are gregarious, inhabiting grassland, cultivated land, scrub, and woodland. They feed on seeds and some insects, and build enclosed nests, often colonially, in grass or undergrowth. *L. striata* (Bengalese finch), commonly kept in captivity, is bred in a variety of plumages. There are 34–41 species, found in Africa, Asia, and Australia.

Lonchura striata (Bengalese finch) *See Lonchura*.

longan (fruit of *Euphoria longana*) *See Euphoria*.

long-day plant Plant in which flowering is favoured by long days and correspondingly short dark periods. There are two groups of such plants, species in which there is an absolute requirement for these conditions (such that flowering will not begin without them) and others in which flowering is merely hastened by them.

longevity The persistence of an individual for longer than most members of its species, or of a genus or species over a prolonged period of geological time.

long-headed flies *See* Dolichopodidae.

longhorn beetle *See* Cerambycidae.

long-horned grasshopper *See* Tettigoniidae.

longicorn beetle *See* Cerambycidae.

Longisquama insignis Named 'remarkable long scale', one of the first archosaurs known to have the ability to glide or parachute. Described from Soviet Kirghizstan in the 1970s, *Longisquama* is noted for the devlopment of elongate paired scales along its back. It is recorded from sediments of Triassic age.

long-legged bat (*Natalus*) *See* Natalidae.

longneck eels *See* Derichthyidae.

longnose chimaera *See* Rhinochimaeridae.

long-nosed batfish (*Ogcocephalus vespertilio*) *See* Ogcocephalidae.

long-nosed viper *See Viper ammodytes*.

long-range forecasting Weather forecasting for periods beyond a few days.

longshore bar Linear ridge of sand whose long axis is parallel to the shore and that is in, or immediately seaward of, the intertidal zone. *See also* ridge and runnel.

longshore current Current that flows parallel to the shore: it is generated by the oblique approach of waves. Tidal current may be superimposed on the longshore current, increasing or decreasing its magnitude.

longshore drift Movement of sand and shingle along the shore. It takes place in two zones. Beach-drift occurs at the upper limit of wave activity, and results from the combined effect of swash and backwash when waves approach at an angle. Movement also occurs in the breaker zone, where currents transport material thrown into suspension.

long-snouted boarfish (*Pentaceropsis recurvirostris*) *See* Pentacerotidae.

longspurs *See Calcarius*.

long-tailed groundroller (*Uratelornis chimaera*) *See* Brachypteraciidae.

long-tailed reef-eel (*Thyrsoidea macrura*) *See* Muraenidae.

long-tailed tits (*Aegithalos*) *See* Aegithalidae.

long tom *See* Belonidae.

long wave Meander in the flow of the circumpolar upper westerly winds, commonly with a wavelength of about 2000 km and sometimes large amplitude. *See also* dishpan experiment; and Rossby waves.

long-whiskered catfish *See* Pimelodidae.

Lonicera (honeysuckles; family Caprifoliaceae) Genus of shrubs or woody climbers, most of them deciduous. The flowers are usually very fragrant, pentamerous, with a corolla that is tabular below and usually strongly two-lipped, but that may be almost regular. The ovary is two-celled, ripening to a few-seeded berry. Honeysuckles are much grown for ornament or, in the case of the evergreen *L. nitida*, for hedges.

Lonicera nitida *See Lonicera*.

Lonsdaleia illipahensis The last member of the genus *Lonsdaleia*, recorded from the Permian. During the Upper Palaeozoic, numerous species of rugose, stony corals were to be found as constituents of reef communities. Among these, the various species referred to the genus *Lonsdaleia* were perhaps the most spectacular. They were colonial corals with a distinct 'platform' area around the inner edge of each skeletal cup, and a prominent central boss.

lontar *See Borassus*.

loofah *See Luffa*.

loopers *See* Geometridae.

loosejaw *See* Malaconsteidae.

loose smut Disease of plants, caused by a member of the Ustilaginales (e.g. species of *Ustilago*) in which the masses of spores are exposed at maturity and can be dispersed freely by wind, etc.

lop and top The branches and top cut from a tree that has fallen or been felled, or, more rarely, from a standing tree.

loph On molar teeth, a ridge connecting cusps.

Lophiidae (goosefish, angler; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of marine fish, with a huge, wide, and flattened head; an enormous mouth whose lower jaw is longer than the upper; and eyes placed almost on top of the head. The fins are short and truncate. The goosefish are bottom-dwelling, and lure prospective prey by means of the movable first dorsal fin ray, which is provided with an illicium (fleshy 'lure') at the tip. Found at depths of 100–1000 m, *Lophius piscatorius* (European angler) can reach a length of 1.7 m. Encountered regularly by commercial fishermen, the annual catch is of the order of 30 000 tonnes. *Lophius americanus* (goosefish) of the W. Atlantic is slightly smaller. There are at least 12 species, with worldwide distribution but absent from the E. Pacific.

Lophiiformes Order of marine, bottom-dwelling fish with a relatively large head, a wide mouth, a short, tapering body and tail, and short, rounded fins. The illicium ('fishing rod'), formed from the modified first dorsal fin situated above the upper jaw, is typical. The order includes 14 families. *See also* Paracanthopterygii.

Lophiodontidae One of several families of ceratomorph perissodactyls, the lophiodonts are known only from Eocene sediments and were closely related to the tapirs.

Lophius americanus (goosefish) *See* Lophiidae.

Lophius piscatorius (European angler) *See* Lophiidae.

Lophocolea (order Jungermanniales) Genus of leafy liverworts. The stems are slender and mainly prostrate. The leaves are obliquely set on the stem and overlap succubously. In *L. bidentata* and *L. cuspidata* the leaves are divided into two sharp points; in *L. heterophylla* some leaves are bidentate but others are more or less entire and rounded. *L. bidentata* grows mainly on soil, in woods, on lawns, etc. *L. cuspidata* and *L. heterophylla* grow mainly on moist rotting wood.

lophodont Applied to teeth that possess lophs.

Lophophorata Coelomates that have two longitudinal coelomic compartments separated by a septum. There are three living lophophorate phyla —Phoronida, Brachiopoda, and Bryozoa—and a number of extinct phyla.

lophophore *See* Brachiopoda; and Bryozoa.

Lophotidae (crestfish; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Small family of marine, open-ocean fish. They have an elongate, greatly compressed body, with the very long dorsal fin commencing above the upper jaw and extending all the way to the tail. The pelvic fins are minute. They have an ink sac containing a dark pigment which can be released through the cloaca when required. *Lophotus capellei* (crestfish) of the E. Pacific may reach a length of 80 cm. There are about two species, distributed worldwide.

Lophotus capelei (crestfish) *See* Lophotidae.

lopolith Concordant igneous intrusion that has a lenticular form. The form of small lopoliths may be controlled by their emplacement in folds, but there is no such obvious control for great lopolithic intrusions.

loppium et chippium The bark, branches, rotten wood, and leaves from a felled tree.

loquat (fruit of *Eriobotrys japonica*) *See Eriobotrys*.

Loranthaceae Family composed of small shrubs that are partially parasitic on trees, with opposite or whorled, entire leaves, and unisexual regular flowers, usually with two-perianth whorls; the ovary is inferior, the fruit a berry. *Viscum* (mistletoe) has tiny tetramerous flowers and white berries. In modern classifications there are some 25 genera, with 600 species. They are mostly tropical, but some are temperate.

Lord Derby's zonure *See Cordylus giganteus*.

lorica Loose-fitting, shell-like covering which encloses the cells of some protozoa.

Loricariidae (armoured catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Very large family of freshwater catfish with the head and part of the body enclosed in bony plates; the posterior part of the body is very slender. The ventrally located mouth is modified into a sucking apparatus which is used by the fish to fasten on to rocks in fast-flowing mountain streams. Like other members of the family, *Loricaria parva* (11 cm) is herbivorous and a common aquarium fish. There are about 410 species, occurring in C. and S. America.

Loricata *See* Polyplacophora.

lories *See Lorius*; Psittacidae; and Psittaciformes.

loris *See* Lorisidae.

Lorisidae (lorises; order Primates, suborder Strepsirhini) Family that includes the lorises, pottos, and galagos (bush-babies). They are related to Malagasy lemurs (Lemuriformes), compared with which they have on average shorter muzzles, higher braincases, and eyes that are directed more forward. In the African potto and angwantibo the index fingers are reduced in size, so providing a wider grip between the thumb and other digits. The lorises of Asia are slow-moving, arboreal, and nocturnal; they feed largely on invertebrates that are unpalatable to other predators, detecting them by smell. The bush-babies are quick-moving and feed on insects (some of which they catch in flight), small

mammals, and some fruit and other plant material. The Lorisidae are distributed throughout the Old World tropics, apart from Madagascar, as far east as Indonesia. There are about 11 species, usually classed in six genera.

Lorisiformes (order Primates, suborder Strepsirhini) Name sometimes given to a group comprising the single family Lorisidae, to contrast them with the Malagasy lemurs (Lemuriformes): the differences (mainly connected with the structure of the auditory bulla) are not very cogent and the distinction is usually dropped nowadays.

Lorius (lories; family Psittacidae) Genus of medium-sized, stocky parrots, which are mainly red and green, with purple and yellow on the wing. They have short, slightly rounded tails, a yellow-orange bill, and a brush-like tongue tip. They inhabit forests, feeding on pollen, nectar, flowers, and fruit, and they probably nest in tree cavities. There are eight species, found in New Guinea, Indonesia, and the Solomon Islands. Many are kept in captivity.

Lota lota (burbot) *See* Gadidae.

Lotella callarias (beardie) *See* Moridae.

lotic Applied to a freshwater habitat characterized by running water, e.g. springs, rivers, and streams.

Lotka–Volterra equations Mathematical models of competition between resource-limited species living in the same space with the same environmental requirements. They have been modified subsequently to simulate simple predator–prey interactions. The competition model predicts that coexistence of such species populations is impossible; one is always eliminated, as was verified experimentally by G. F. Gause. The predation model predicts cyclic fluctuations of predator and prey populations. Reduction of predator numbers allows prey to recuperate, which in turn stimulates the population growth of the predator. Increasing predator numbers depress the prey population, leading eventually to a reduction in the predator population. This was also tested experimentally by Gause (1934) and more recently and more convincingly by S. Utida (1950, 1957). *See also* competitive-exclusion principle.

lotus fruit *See Zizyphus*.

louping-ill Disease that affects mainly sheep but may also affect cattle. The disease involves the loss of co-ordination of movements, which is followed by paralysis; it is often fatal. It is caused by a flavivirus, and transmitted by ticks.

louse *See* Phthiraptera.

louvar (*Luvarus imperialis*) *See* Luvaridae.

Lovettia sealii (Derwent whitebait) *See* Aplochitonidae.

low Common term for a low-pressure system, e.g. a depression.

low arctic tundra The southernmost latitudinal sector of the arctic tundra, distinguished from the more northerly belts by the presence of a continuous vegetation cover in most areas. The plant communities form a vegetation mosaic, which reflects the importance of microhabitats in this harsh, exposed environment.

lower fungi Fungi belonging, for example, to the Mastigomycotina and the Zygomycotina.

Lowiaceae Small family of one genus of forest herbs related to bananas (Musaceae). They are rhizomatous and stemless. Their flowers are bisexual and trimerous, with one enlarged sepal and petal, and a long hypanthium.

Loxia (crossbills; family Fringillidae) Genus of stout finches in which the males are brick-red, the females yellow-green. The bill has crossed mandibles, an adaptation that assists in opening pine cones. Crossbills inhabit coniferous woodland, feed on conifer seeds, and nest in trees. They often irrupt (migrate in large numbers into areas in which they are otherwise uncommon) if cone crops fail. There are four species, found in Europe, Asia, N. Africa, and N. and C. America.

Loxioides (Hawaiian honeycreepers; family Drepanididae) Genus of stocky, finch-like birds, which have short, very stout bills. They are mainly olive, some with yellow or orange on the head and neck. They inhabit forest, feed on seeds, and nest in trees. There are two living species, confined to Hawaii; three other species are extinct. They are often placed in the genus *Psittirostra*.

Loxodonta (African elephant; order Proboscidea, suborder Gomphotherioidea, family Elephantidae) Genus of elephants that is believed to have evolved from the same Pliocene stock as *Elephas* and *Mammuthus* but to have changed more slowly than *Elephas*. In loxodonts the molars are narrower, and less thickly and elaborately plated than in *Elephas*; the head is longer, not domed; the tusks are longer and more forward-facing; and the back does not slope downward toward the rear. *Loxodonta* have been confined to Africa throughout the history of the genus. There is one living species, *L. africana*, the African elephant.

Loxosceles reclusa (brown recluse spider; suborder Araneomorphae, family Loxoscelidae) Species of spider which has six eyes in three groups and is similar to members of the Scytodidae, but does not spit. Prey is overcome with poison after becoming trapped in an irregularly-shaped sheet web. The bites of all species of *Loxosceles* are poisonous to mammals, and produce a necrotic wound, local swelling, and in serious cases ulceration. The species is widespread in the Americas, especially from Georgia to central Indiana, and west to E. Texas. *See also* necrosis.

Loxsomaceae Family of ferns in which the much-divided fronds arise from creeping rhizomes and have their sori, which are of gradate type, in cup-like indusia terminally on the leaf veins on the leaf margins. The sporangia have a complete oblique annulus. There are two genera: *Loxsoma*, with only one species, in New Zealand, and *Loxsomopsis*, with three species, in C. and S. America.

LPP group Group of closely related cyanobacteria, comprising the genera *Lyngbya*, *Phormidium*, and *Plectonema*.

lubber grasshopper *See* Acrididae.

Lucanidae (stag beetles; class Insecta, order Coleoptera) Family of large, shiny, brown or black beetles, 10–66 mm long, in which the mandibles of males are often developed into 'antlers', which are probably used in fighting between males. The antennae are elbowed, with clubs of flattened, expanded segments. There is a wide size range within species, females generally being smaller. Britain's largest beetle is *Lucanus cervus* (great stag beetle). The mandibles are much less developed in *Dorcus parallelipipedus* (lesser stag beetle) and *Sinodendron cylindricum* (small stag beetle). The larvae are curved, and fleshy. Their antennae are well developed, their legs slender. They live in rotting wood, taking 3–6 years to develop. They stridulate by rubbing the last two pairs of legs together. Adults feed on sap and liquids. There are 750 species.

Lucanus cervus (great stag beetle) *See* Lucanidae.

Lucernarida Alternative name for Stauromedusida.

lucerne (alfalfa) *See Medicago*.

luciferase In the bioluminescence reactions of the firefly, the enzyme that catalyses the oxidation of the substrate luciferin, with the consequent release of visible light.

luciferin *See* luciferase.

Luciocephalidae (pikehead; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of freshwater fish. *Luciocephalus pulcher* (pikehead) is a predatory surface fish with an elongate, nearly cylindrical body, a very pronounced or even pointed snout, and large eyes. The dorsal and anal fins are placed far back, with the anal fin showing a deep notch. The fish has an accessory respiratory organ for air-breathing. Reaching a length of about 20 cm it has some commercial value as a food and aquarium fish. It is found in Malaysia.

Luciocephalus pulcher (pikehead) *See* Luciocephalidae.

luderick (*Girella tricuspidata*) *See* herbivorous fish; and Kyphosidae.

Luffa (family Cucurbitaceae) Genus of six species of tendrillate climbers of the tropics, including *L. cylindrica*, which furnishes the loofah, the vascular skeleton of the pericarp.

lugworms *See* Sedentaria.

lumbar vertebra One of the vertebrae posterior to the thoracic, rib-bearing, vertebrae, and anterior to the sacral (pelvic-region) vertebrae.

luminous night clouds *See* noctilucent clouds.

Lumnitzera (family Combretaceae) Genus of big trees of mangrove swamps, whose fruits float, and which yield useful timber. There are two species, occurring in E. Africa and from the Malay archipelago to the Pacific islands.

lumpsucker *See* Cyclopteridae.

lumpy jaw Chronic disease which affects cattle and other animals. Nodules develop on the jawbone, causing swelling of the jaw. The causal agent is *Actinomyces bovis*.

lumpy-skin disease Infectious disease of cattle, found in parts of Africa; the causal agent is a virus of the poxvirus group. Symptoms include the development of skin swellings. The disease is rarely fatal, but it reduces the productiveness of livestock and is therefore economically important.

lunate Half-moon shaped.

lung 1 In terrestrial Mollusca, a highly vascular part of the mantle involved in respiration. 2 In air-breathing vertebrates, the respiratory organ. It is probably derived from an accessory respiratory organ of aquatic vertebrates inhabiting oxygen-depleted fresh water: this developed into the swim-bladder of many fish. The lung is present embryonically as a diverticulum of the gut. It contains many alveoli across whose walls oxygen and carbon dioxide diffuse. *See also* alveolus.

lungbook *See* book lung.

lungfish *See* aestivation in fish; air breathing in fish; Lepidosirenidae; and Lepidosireniformes.

lungless salamanders *See* Plethodontidae.

Lunularia (order Marchantiales) Genus of thallose liverworts, which are immediately recognizable by the crescent-shaped ridges of tissue on the surface of the thallus; these protect small discoid gemmae. *L. cruciata* is very common in gardens, on flower-pots, moist brick, rockery stones, paths, etc.; it is also found on the ground in woods and by streams, etc.

lunule *See* Scutellina.

lupin *See Lupinus*.

Lupinus (lupin; family Leguminosae) Genus mostly of herbs (a few of which are shrubby), with palmately compound leaves and erect, terminal, leafless racemes of showy flowers. Lupins are much cultivated in gardens. There are some 300 species, mostly in N. America, but a few are native in Europe.

Luscinia (nightingales, rubythroats, bluethroats; family Turdidae) Genus of small, brown thrushes, many of which have red or blue throats or body feathers. They are secretive, living in thick undergrowth and woodland, where they feed mainly on insects, and nest on the ground. *L. megarhynchos* (nightingale) is noted for its song. There are 7–18 species, all or many of which are often placed in the genus *Erithacus*, found in N. America, Europe, Africa, and Asia. Many are migratory.

Luscinia megarhynchos (nightingale) *See Luscinia*.

Lusitanian floral element Geographical element of the British flora, including plants such as *Erica mackiana* (Mackay's heath) that are found in W. Ireland and that reappear again only far to the south, in the Iberian peninsula. These plants are generally thought to have migrated north to Ireland

early in the postglacial period, before sea-level was fully restored.

lustre Of minerals, the ability to reflect light. The quality and nature of the reflection may be a useful diagnostic aid. The term 'lustre' is often used in conjunction with the qualifying terms 'adamantine', 'metallic', 'resinous', 'waxy', 'pearly', 'silky', and 'vitreous'.

luteinizing hormone (LH) Gonadotropic protein hormone, secreted by the adenohypophysis (anterior pituitary) that stimulates in the male the production of testosterone and in the female the final ripening and rupture of the ovarian follicles. *See also* corpus luteum.

Lutjanidae (snapper; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of mainly marine fish which have rather deep bodies. The continuous dorsal fin is slightly notched, and the tail-fin is slightly forked. The jaws bear large canine teeth. Snappers are important food fish and popular with fishermen, but may sometimes carry ciguatera poison. *Lutjanus argentimaculatus* (mangrove jack), 91 cm, may enter estuaries along the N. Australian coast. *Lutjanus sebae* (red emperor), 1.1 m, of the same region, is equally popular. About 230 species are distributed throughout the tropical seas.

Lutjanus argentimaculatus (mangrove jack) *See* Lutjanidae.

Lutjanus sebae (red emperor) *See* Lutjanidae.

Lutz phytograph In the phytosociological assessment of woodland communities (especially tropical woodlands), a polygonal figure representing four structural characteristics of each major tree species present, usually (a) the percentage of the total number of trees that are larger than 25 cm diameter at breast height (dbh); (b) the percentage frequency of a particular species in the total number of trees larger than 25 cm dbh; (c) the occurrence of the species in each of five size classes reflecting maturity; and (d) the dominance of the species as reflected by its percentage of the total tree basal area.

Luvaridae (louvar; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine tropical fish of the open sea, comprising *Luvarus imperialis* (louvar). This is a large fish (up to 2 m) with a robust, deep body, a blunt head, a small mouth, long dorsal and anal fins, and a narrow tail with a lunate (half-moon shaped) tail-fin. The anus is located between the minute pelvic fins, a rather unusual position in fish. The louvar has worldwide distribution in tropical and subtropical seas.

Luvarus imperialis (louvar) *See* Luvaridae.

lyase Enzyme that catalyses non-hydrolytic reactions in which groups are either removed or added to a substrate, thereby creating or eliminating a double bond, especially between carbon atoms (C=C) or between carbon and oxygen (C=O).

Lybius (barbets; family Capitonidae) Genus of mainly black and white birds, many of which have red on the head or belly. They have stout bills, with grooved upper mandibles. They are found in forest, open woodland, and scrub, where they feed on fruit and insects, and nest in holes in dead trees. There are 12 species, found in Africa.

Lycaenidae (blues, hair-streaks, coppers; order Lepidoptera) Very large family of small to medium-sized butterflies. Coloration is often brilliant metallic, and sexual dimorphism is widespread. 'Tails' are often present on the hindwings. The forelegs of males are slightly reduced. The larvae are frequently associated with ants, and some species prey on aphids and scale insects. Distribution is widespread, but mainly tropical and subtropical.

Lycaon pictus (hunting dog) *See* Canidae.

lychee *See Litchi*.

Lycidae (net-winged beetles; class Insecta, order Coleoptera) Family of brightly coloured, distasteful beetles, 5–20 mm long, which are often mimicked by harmless insects. The elytra have pronounced longitudinal ridges. The pronotum is expanded and ridged, covering most of the head. The antennae are long and thick, often serrate or pectinate, and placed close together on the head. The eyes are protruberant. Some are sexually dimorphic, with larviform females. Larvae are usually found in dead trees. Their antennae are much reduced. Both adults and larvae are predatory. There are 3000 species, mostly tropical.

Lycium (Duke of Argyll's tea-plant; family Solanaceae) Genus of often spiny shrubs with entire, clustered or alternate leaves. The flowers have funnel-shaped, five-lobed corollas, and the stamens inserted at the mouth of the corolla are long and protruding. The fruit is a berry, retained in the calyx. They are much cultivated, and naturalized in Europe and elsewhere. There are some 120 species, occurring in temperate and subtropical areas.

Lycogala (order Liceales, class Myxomycetes). Genus of cellular slime moulds whose fruiting bodies (aethalia) resemble small puff-balls. *L. epidendrum* is one of the commonest myxomycetes and is cosmopolitan in distribution. It is found on dead wood in woodland habitats.

Lycoperdales (class Gasteromycetes) Order of terrestrial fungi in which the mature fruit body occurs above ground although its development may begin below ground. The fruit body is more or less spherical. The spores are contained within a peridium which is usually composed of at least two layers: the exoperidium and endoperidium. There are many genera. The order includes the puff-balls and earth stars.

Lycoperdon (order Lycoperdales) Genus of fungi in which the fruit bodies typically grow on the ground (*L. pyriforme* grows on rotten wood). The exoperidium is spiny or scaly; the endoperidium opens by a regular pore at the apex through which the spores escape. There are 25 species. *See also Calvatia*.

Lycopodiaceae Family of Lycopsida within the Pteridophyta, with small, simple, usually narrow

leaves, which clothe the forking stems or, as in *Phylloglossum*, arise from the base of the naked, unbranched stem. The stems bear sporangia in the axils of either normal or highly modified leaves, either along their length in alternating sterile and fertile zones, or (in most species) in clearly differentiated terminal cones. All sporangia are alike and contain numerous minute spores, which germinate to produce sexual gametophytes. Unlike Selaginellaceae the leaves have no ligule on their upper-side. The family is very ancient and similar plants have been found as fossils in Devonian and Carboniferous rocks. They are now divided into five genera, which contain some 180 species, some of which are cosmopolitan in distribution.

Lycopsida Subdivision of the Pteridophyta, represented today by the club mosses (families Lycopodiaceae, Selaginellaceae, and Isoetaceae), although in the Carboniferous they included large trees. The oldest lycopods date from the Devonian and derived from the most primitive of vascular plants, the Psilophytopsida.

Lycosidae (hunting spiders, wolf spiders; order Araneae, suborder Araneomorphae) Family of medium to large spiders that run over the ground hunting for their prey. Some genera are burrowing (up to 1 m deep) and others make funnel-shaped webs. Females carry their egg cocoons, which can be quite large, attached to their circularly arranged spinnerets. Many species of *Pardosa* live in northern latitudes and are gregarious, but not social.

Lyctidae (powder-post beetles; class Insecta, order Coleoptera) Family of small, elongate, parallel-sided beetles, distinguished from other wood-borers by having a smaller pronotum, which leaves the head visible. The antennae have two-jointed clubs. Larvae are white, fleshy, and C-shaped, with the head largely covered by the prothorax. They attack the heartwood of deciduous trees, but never conifers, reducing wood to a powdery dust, much finer than that made by furniture beetles (Anobiidae). There are 70 specie

Lydekker's line Defines the easternmost extension of Oriental animals into the zone of mixing between the Oriental and Australian faunal regions or zoogeographic kingdoms. The corresponding western limit of the zone is known as Wallace's line, and marks the maximum extent of marsupials in that direction.

Lygaeidae (order Hemiptera, suborder Heteroptera) Family of bugs, many of which feed on ripe seeds, whereas others (e.g. the N. American chinch bug), destroy the shoots of grasses. Some are predators. Most species live on the surface of the ground and many are flightless. There are about 2000 species, distributed worldwide.

Lymantria dispar (gypsy moth) *See* Lymantriidae.

Lymantriidae (tussock moths; order Lepidoptera) Family of generally medium-sized moths. In contrast to the Noctuidae, the proboscis is usually absent, and the antennae are bipectinate in males and usually so in females too. Sometimes females are wingless. The larvae are hairy, often brightly coloured, and hairs are frequently woven into the coccoon. *Lymantria dispar* (gypsy moth) was supposed to be extinct in Britain from about 1850, but several individuals have been identified since the late 1960s. There are about 2000 species. The family has a wide distribution.

lymphadenitis Inflammation of a lymphatic gland due, e.g. to bacterial infection.

lymphocyte *See* leucocyte.

Lyngbya (order Nostocales) Genus of filamentous cyanobacteria in which each filament is surrounded by a sheath. The filaments are capable of gliding motility. They may be free-floating or mat-forming. They are found in all types of aquatic environment and on wet rocks, damp soil, etc. Heterocysts and akinetes are not formed, and the organisms are difficult to distinguish from *Phormidium* or *Plectonema* (the LPP group). Blooms of *Lyngbya majuscula* appear to be responsible for dermatitis in swimmers, a condition known as 'swimmers' itch'.

Lynx (superfamily Feloidea, family Felidae) Genus or subgenus of felids (included by most authorities in *Felis*). Lynxes are medium-sized cats in which the tail is short, the legs long, the paws large, the ears tufted, and the head short and broad. There are four species. *L. lynx*, including *L. canadensis* (northern lynx), inhabits forests in Eurasia and N. America and is the largest wild European felid. *L. rufus* (bobcat, or bay lynx) is exclusively N. American with a range extending from S. Canada to Mexico; it is smaller than the northern lynx, less arboreal, and inhabits deserts as well as forests. *L. pardina* (Spanish lynx) is convergent with the bobcat in appearance and ecology. *L. caracal* (caracal, or desert lynx) is small and plain-coloured, with enormous ears with long tufts; it lives in Africa and W. Asia. *See also* Felidae.

lyrebirds *See* Menuridae.

Lyrurus (black grouse) *See Tetrao*.

Lysenko, Trofim Denisovich (1898–1976) A fanatic anti-geneticist, who attained extraordinary power in the USSR under Stalin, and retained it under Khrushchev. He sought successfully the suppression of research in genetics and was responsible for the imprisonment and execution of a number of noted Soviet geneticists. The failure of his own attempts, based on a kind of Lamarckism, to increase grain production led to his own downfall and that of Khrushchev.

lysimeter Device for the direct estimation of evapotranspiration. Typically it comprises a vegetated block of soil 0.5–1 m^3, to which the amount of water added is known, and from which the amount lost as run-off or percolation may be measured. Recording the changing weight of the soil-vegetation system (keeping vegetation change due to growth static or monitored) reveals the amount of water retained by the system, and thus by difference the amount lost as evapotranspiration. For geographic comparisons, easily standardized, short, grass vegetation cover is used. For water-budget experiments, vegetation cover may be

varied to simulate different crop types or semi-natural communities.

lysine Aliphatic, basic, polar amino acid that is generally abundant in animal proteins, but of limited occurrence in those of plants.

lysis *See* lytic response.

lysogeny Stable, non-destructive relationship between a bacteriophage and its host bacterium; the genome of the bacteriophage may become integrated with that of its host. Under certain conditions the stable relationship breaks down and the phage may then destroy the bacterium.

lysosome Membrane-bound vesicle in a cell that contains numerous acid hydrolases capable of digesting a wide variety of extra- and intracellular materials. Lysosomes apparently originate from the Golgi body, and function by fusing with and discharging their contents into a vacuole containing the material to be digested.

lysozyme Bacteriolytic enzyme found in a number of biological fluids, including tears, saliva, and egg white. It facilitates the hydrolysis of structural polysaccharides in the cell walls of bacteria.

Lystrosaurus Genus of mammal-like reptiles, prominent among those that dominated vertebrate faunas during the Early Triassic. It lived in the southern continents and was a swamp-dwelling herbivore, stoutly built and tusked.

Lythraceae Family of herbs, with a few shrubs and trees, in which the leaves are opposite or whorled, the flowers regular, with 4–6 (or no) free sepals and petals, 4–12 stamens, and a 2–6-celled, superior ovary. The fruit is a capsule. There are 20 genera, with 500 species, with a cosmopolitan distribution except for arctic zones.

Lythrum (family Lythraceae, tribe Lythreae) Genus of herbs and shrubs with leaves either in whorls or opposite, usually simple and with small or no stipules. The flowers are regular and bisexual, usually solitary, with 12 stamens in two whorls of different lengths. The fruit is a dry capsule, with numerous seeds without endosperm. There are 35 species, found throughout the world.

lytic response Rupture and death (lysis) of a bacterial cell following infection by a phage which then reproduces inside the cell, as opposed to a lysogenic response in which the infecting phage does not multiply but instead behaves as a prophage.

Lytta vesicatoria (Spanish fly) *See* Meloidae.

M

maar Crater, often occupied by a shallow lake, produced by an explosive volcanic eruption. Normally it is surrounded by a low rampart or ring of ejected material. A gas maar results when little or no debris is emitted. The subsidence of a volcanic pipe may produce a special variety of maar.

Maastrichtian (Maestrichtian) Final stage of the Cretaceous in Europe. The stratotype is described from the Maastricht area of Holland. Throughout W. Europe, the Maastrichtian is characterized by chalk limestones.

Macaca (macaques) *See* Cercopithecidae.

Macadamia (family Proteaceae) Genus of shrubs and trees, which yield oily, edible seeds. There are nine species. One is found in Madagascar; one in Celebes; three in New Caledonia; and five in Australia. *M. ternifolia* is cultivated, providing the Queensland nut, or macadamia.

macaque (*Macaca*) *See* Cercopithecidae.

Macaranga (family Euphorbiaceae) Genus of trees, in which the leaves are often palmately lobed or nerved with conspicuous stipules. Some have hollow, ant-inhabited twigs. Many are fast-growing pioneer trees with soft wood. There are 250 species, occurring in tropical and subtropical forests from Africa to Polynesia, S. China, and Queensland.

Macaronesian floral region Region comprising the Canaries, Madeira, and the Azores, in which few genera are endemic (perhaps less than 30); surprisingly, the most remote island group, the Azores, has no endemics. The flora of the Canaries displays a notably high frequency of succulents belonging to the Crassulaceae, in particular the genus *Sempervivum*.

macassar oil *See Cananga*.

macaw *See Ara*.

macchia *See* maquis.

Maccullochella peeli (Murray cod) *See* Percichthyidae.

mace Spice obtained from the aril of *Myristica fragrans*. *See Myristica*.

Machaeridia (phylum Echinodermata) Extinct class, ranging in age from Ordovician to Devonian, of animals in which the body is enclosed in an elongate, bilaterally symmetrical shell composed of an even number of longitudinal columns of plates. Machaerids are usually placed among the echinoderms because their plates are of crystalline calcite and show typical cleavage, but they have also been regarded as polyplacophoran molluscs, annelid worms, and cirripede crustaceans.

machair Level, sandy, grass sward that has developed over a long period by the accumulation of blown sand behind coastal sand-dunes, occurring most typically in the Hebrides and along the north-west coast of Scotland.

Machilidae (subclass Apterygota, order Archaeognatha) One of the two present-day archaeognathan families, whose member species are active jumpers, usually found under bark and stones, or among rocks along the seashore. Unlike the Meinertellidae, this family is found principally in the northern hemisphere. The common species *Petrobius maritimus* lives in crannies on coastal cliffs not far above the high-tide mark.

Machiloidea (subclass Apterygota, order Archaeognatha) Superfamily whose members are divided into two groups, one in the northern hemisphere and one in the southern.

mackerel *See* Scombridae.

mackerel sky Pattern of wavy cirrocumulus (or altocumulus) cloud with holes which produces an overall resemblance to the body markings of mackerel. *See also* vertebratus.

Macquarie perch *See* Percichthyidae.

macrobiota (macrofauna, macroflora) General term for the larger soil organisms which may be hand-sorted from a soil sample. 'Macrofauna' in particular refers to burrowing vertebrate animals (e.g. rabbits and moles), while 'macrobiota' generally also includes larger plant material (e.g. tree roots). Some workers also include larger insects and earthworms in this category, but others consider them part of the mesobiota. *Compare* mesobiota; and microbiota.

Macrocheira kaempferi (giant spider crab, Japanese island crab; order Decapoda, family Majidae) Species of crab, which has the largest leg span of any known arthropod, attaining in males some 4 m across the chelipeds. The chelipeds of females are much smaller. The cephalothorax may attain a length of 0.5 m. The crab is found on the continental shelf at depths of 50–300 m, and is regarded by the Japanese as a great delicacy.

macroclimate The climate character of a large region.

Macrocnemus basanii Small lizard, described from the Triassic of Switzerland by Nopsca. It was amongst the first representatives of the order Squamata.

macroconsumer *See* consumer organism.

Macrocystis (order Laminariales) Genus of large brown seaweeds in which the thallus may reach lengths of 50 m or more. The upper portions of the plant float on the sea surface, buoyed up by air bladders. *Macrocystis* can grow in much deeper waters than most other seaweeds, e.g. to depths of

30 m or more in clear seas. It occurs in Antarctic regions, on the Pacific coast of N. America, and off the shores of S. Africa. In the USA, *Macrocystis* is harvested as a valuable source of algin.

Macrodasyoida (phylum Aschelminthes, class Gastrotricha) Order of microscopic, aschelminth worms in which the male genitalia always occur. All inhabit marine habitats.

macroevolution Evolution above the species level, i.e. the development of new species, genera, families, orders, etc. There is no agreement as to whether macroevolution results from the accumulation of small changes due to microevolution, or whether macroevolution is uncoupled from microevolution.

macrofauna *See* macrobiota.

macroflora *See* macrobiota.

macromere *See* blastomere.

macromolecule Molecule that has a high molecular weight, often a polymer.

macronutrient Organic or inorganic element or compound, that is needed in relatively large amounts by living organisms. Organic macronutrient organic groups include amino acids, carbohydrates, and fats. *Compare* micronutrient; *see also* essential element.

macrophage Large, phagocytic, white blood cell, which occurs in large numbers at sites of infection where it is instrumental in removing foreign cells and cell debris. Macrophages are derived from monocytes as a result of the monocytes' participation in phagocytic activity.

Macropharyngea *See* Nuda.

Macropis *See* Melittidae.

Macropodidae (kangaroos, wallabies; order Marsupialia, superfamily Phalangeroidea) Family of herbivores, in which the lower incisors are directed forward and can be moved against one another like shears; the molars are modified for intensive grinding; and the stomach has a sacculated, non-glandular, rumen-like chamber containing symbionts. The ilia and thigh muscles are modified for bipedal motion and the fourth metatarsal is elongated. Kangaroos and wallabies are mainly terrestrial, but in the semi-arboreal tree kangaroos the forelimbs are almost as long as the hind limbs. The ground-dwelling rat kangaroos possess prehensile tails. There are about 60 species, all native to Australia and New Guinea.

Macropodus opercularis (paradise fish) *See* Belontiidae.

Macrorhamphosidae (snipefish, bellowsfish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Small family of marine tropical and subtropical fish, which have a compressed and deep body. The long, stout second dorsal spine of the dorsal fin and the long, tubular snout are characteristic. The fish have large eyes and short fins, and the body is partially enclosed in armour (consisting of bony plates). *Macrorhamphosus elevatus* (common bellowsfish), 15 cm, of S. Australia often moves in large schools at depths of 25–160 m. There are about 11 species, distributed worldwide.

Macrorhamphosus elevatus (common bellowsfish) *See* Macrorhamphosidae.

Macroscelidea (Macroscelididae, elephant shrews; order Insectivora) Suborder of omnivorous mammals (often classed as a separate order) in which the hind limbs are elongated, enabling the animals to jump well, and the snout is elongated. The molars are large and squared, like those of ungulates. Macroscelids are known from the early Oligocene and are believed to be an evolutionary offshoot from a primitive insectivore stock, confined to Africa and with no close living relatives. There are many species, found in N. Africa and south of the Sahara.

Macroscelididae *See* Macroscelidea.

Macrotermitinae *See* Termitidae.

macrotidal Applied to coastal areas where the tidal range is in excess of 4 m. Tidal currents dominate the processes active in macrotidal areas, e.g. the coast of the British Isles.

Macrouridae (Macruridae; grenadier, whiptail; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Large family of marine mid-water fish with very long dorsal and anal fins tapering down to the pointed tip of the tail, the tail-fin being absent. The blunt head has large eyes and often shows a chin barbel. The small pelvic fins are usually located under or in front of the pectorals; all fins are spineless. Like most grenadiers, *Coryphaenoides rupestris* (European grenadier), 1 m, lives near the sea-bottom at depths of 200–1200 m. The commercial importance of the grenadiers may well increase in the near future. There are about 250 species, distributed worldwide.

Macrozamia (family Zamiaceae) Genus of cycads present as an understorey in *Eucalyptus* forests and woodlands. There are 14 species, found in most parts of Australia and in New Guinea. Their distribution may have been more extensive in the past.

Macrozoarces americanus (ocean pout) *See* Zoarcidae.

Macruridae *See* Macrouridae.

Madagascan faunal region The strongly endemic and insular fauna of Madagascar, with five orders found nowhere else. For example, four of the five families of lemurs survive only in Madagascar; and it is significant that this is the only part of the African continent from which the more advanced apes and monkeys are entirely absent.

Madagascan floral region Part of Good's (1974) Palaeotropical kingdom, which geographically includes Madagascar, the Seychelles, and the Mascarenes. A high proportion of the genera, perhaps exceeding 200, is endemic; and depending on the taxonomic system adopted, there are two or three endemic families.

made ground (made land) Area of land that has been man-made, generally through the reclamation

of marshes, lakes, or shorelines. An artificial fill is used, consisting of natural materials, refuse, etc.

Madeira cockroach *Leucophaea maderae*. *See* Blaberidae.

made land *See* made ground.

Madhuca (family Sapotaceae) Genus of small to big evergreen trees in which the leaves are spiral, and sometimes clustered. The flowers have four sepals, and 6–16-lobed petals. There are 75 species, occurring in SE Asia, and centred on Malesia.

Madreporaria (stony corals; subclass Zoantharia) Order of solitary or, more commonly, colonial corals, which always possess an external ectodermal, calcareous skeleton consisting essentially of radial partitions or septa. Septa develop following the pattern of mesenteries in cycles of 6, 12, 24, 48, etc. They first appeared in the Middle Triassic.

madreporite In Echinodermata, a button-shaped process on the aboral surface of the body; through its opening the water-vascular system is connected to the water outside.

madroña laurel (*Arbutus menziesii*) *See Arbutus*.

Madura foot Disease of the foot in humans, which occurs mainly in tropical regions; the foot swells and pus-discharging lesions develop. The condition is commonly due to infection by one of several fungi, but may also be caused by bacteria.

Maestrichtian *See* Maastrichtian.

maestro Local north-westerly wind of the Adriatic Sea which affects the western coasts, especially in summer. The term is also applied to north-westerly winds in the Ionian Sea and to winds off the coasts of Corsica and Sardinia.

magma Molten, silicate materials, which are derived from the interior of the Earth, and which include crystals, entrained rocks, and dissolved gases.

magnesium (Mg) Element found in high concentrations in plants. It plays an important role in the chemical structure of chlorophyll and of membranes and is involved in many enzyme reactions, especially those catalysing the transfer of phosphate compounds. Deficiency can produce various symptoms, including chlorosis and the development of other pigments in leaves.

magnetic pyrite *See* pyrrhotine.

magnetic storm Major disturbance of the Earth's magnetic field resulting from the passage of high-speed charged solar particles, following a solar flare. The particles are deflected towards the regions of the Earth's magnetic poles.

magnetic striping Phenomenon, discovered originally in the NE Pacific Ocean, of linear magnetic anomalies which lie parallel to oceanic ridges where spreading has occurred. The striping, which is determined by instrumental measurements, results from repeated reversals of the Earth's magnetic field: it exists as corresponding patterns on either side of an oceanic spreading centre. The discovery led to the theory of sea-floor spreading.

magnetite Mineral, specific gravity 4.9–5.2, hardness 5.5–6, chemical composition Fe_3O_4. It is found extensively in magmatic rocks associated with basic rocks; in pegmatites; in contact metasomatic zones, especially in limestones in regionally metamorphosed rocks due to the dehydration of iron hydroxides; and also in black sands associated with gold gravels. It is distinguished by its strong magnetic properties, and its black streak. It is normally iron-black with a blue tarnish, and has a black streak and a sub-metallic lustre. It crystallizes in the cubic system. The crystals are often octahedral and rhombododecahedral, but it is also massive and granular.

magnetochronology Geochronological system that is based on geomagnetic polarity reversals. As no theory yet specifies the existence and duration of separate geomagnetic/polarity intervals, a true magnetochronology is said not to exist.

magnetosphere The highest regions of the atmosphere, in which ionized particles are affected by the magnetic field of the Earth. The charged particles oscillate between the northern and southern hemispheres. The term includes the exosphere, where ionized particles increase in number. In the magnetosphere, charged particles are concentrated at about 3000 km and 1600 km altitude. The outer boundary of the magnetosphere is sharp and well defined, extending to about 10 Earth radii on the sunlit side of the Earth and to perhaps 40 Earth radii on the dark side; but the boundary changes its position in response to solar activity, being depressed by the solar wind. *See also* exosphere; and ionosphere.

magnetostratigraphy Branch of stratigraphy based on geomagnetic polarity reversals.

Magnolia (family Magnoliaceae) Genus of trees and shrubs with showy flowers, many of which are cultivated as ornamentals. The tepals are petaloid. The stamens and carpels are in an elongate receptacle, and fruiting carpels are follicular. *Magnolia* is one of the most ancient of flowering plants, noted for the relatively primitive structure of its flower. *Magnolia* leaves are first recorded from Dakota, USA, in the Lower Cretaceous. There are 80 species occurring from the Himalayas to Japan and W. Malaysia, and in southern N. America to Venezuela and the W. Indies.

Magnoliaceae Family of trees and shrubs, which have aromatic bark. The leaves are simple, with large stipules which enclose the apical bud and leave a scar. The flower parts are numerous, free, and spirally arranged. The fruits are usually dehiscent, and the seeds mostly large and arillate. They yield useful timber and ornamental flowers. There are 12 genera, with 220 species, centred on temperate and tropical Asia, but also occurring in N. and S. America.

magpie goose *See Anseranas*.

magpie larks *See* Grallinidae.

magpies 1 *See* Corvidae. 2 (Australian magpie, *Gymnorhina tibicen*) *See Gymnorhina*.

Mahalanobis' D^2 Measure of generalized distance between samples based on the means, variances, and covariances of various properties of replicate samples in multivariate analysis. The larger is D^2, the greater is the difference between the samples (or the properties measured).

mahogany *See Swietenia*.

Mahonia (family Berberidaceae) Genus of evergreen shrubs, with pinnate leaves, and an inflorescence in the form of a raceme or panicle of trimerous flowers. The flowers usually have five whorls of similar perianth segments, two whorls of stamens, and an ovary of one carpel which develops into a berry. They are cultivated for their ornamental foliage, flowers, and fruits, which are like tiny, blue-black grapes (Oregon grapes). There are some 50 species, occurring in E. Asia and N. America.

mahseer (*Barbus tor*) *See* Cyprinidae.

maiden Tree arising from a seed, or more rarely a sucker, that has not been coppiced or pollarded.

maidenhair ferns *See Adiantum*.

maidenhair tree (*Ginkgo biloba*) *See Ginkgo*; and Ginkgoales.

maintenance evolution (stabilizing selection, normalizing selection) The stabilizing influence of natural selection in an environment that changes little in space and time. It tends to inhibit evolutionary innovation, and accounts for the fact that many fossil groups changed very little over long periods of time.

Maireana Former plant genus that is now included in the genus *Kochia*.

Maja squinado (spiny spider crab; subclass Malacostraca, order Decapoda) Species of spider crab which grazes on algae, hydrozoans, and bryozoans. Males and pre-adult females form groups in July, the older, armoured males protecting the newly-moulted females on the inside of the group. Maturation occurs by mid-August. Individuals attain 8–11 cm in length. They occur along the south-west coast of Europe and in the Mediterranean.

Majidae (spider crabs; subclass Malacostraca, order Decapoda) Family comprising slow-moving, marine crabs, whose carapace is longer than it is wide. The chelipeds are usually not much longer than the other pereopods, and the body and appendages are equipped with hooked setae for the attachment of camouflage derived from pieces of seaweed, sponges, hydrozoans, bryozoans, and ascidian colonies. Some species lie among the spines of sea urchins and the tentacles of anthozoans, from which they derive a degree of protection.

major gene Gene with pronounced phenotypic effects, in contrast to a modifer gene, which modifies the phenotypic expression of another gene.

Makaira nigricans (blue marlin) *See* Istiophoridae.

mako shark (*Isurus oxyrinchus*) *See* Lamnidae.

Malacanthidae (tilefish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish, known formerly as Branchiostegidae, found mainly in tropical and temperate waters. The rather elongate body possesses long dorsal and anal fins and a truncate tail-fin, the pelvic fins being located under the pectorals. Although many species are less than 40 cm long, *Caulolatilus princeps* (ocean whitefish) of the E. Pacific reaches a length of more than one metre and is popular with fishermen. There are about 24 species.

malacca cane Walking stick made from a single internode of the rattan *Calamus manan*, the value increasing markedly with length.

malachite Mineral, specific gravity 3.9–4.0, hardness 3.5–4.0, and with the chemical composition $Cu_2CO_3(OH)_2$, whose name is derived from the Greek for 'hollyhock'. It is a common secondary mineral in the oxidized zone of copper deposits, and is associated with azurite, native copper, and cuprite. It is distinguished by its colour, botryoidal form, and solubility with effervescence in dilute hydrochloric acid. It is bright green and has a pale green streak, and a fibrous, silky lustre. It crystallizes in the monoclinic system. Crystals are very rare, and it is usually found as botryoidal, encrusting masses with bands of varying colour, and frequently in a fibrous, radiating habit. It is often used for ornaments and pigments, and as an ore for metallic copper.

Malacochersus tornieri (pancake tortoise; order Chelonia (Testudines), suborder Cryptodira, family Testudinidae) Species of tortoise which is an agile climber on high rocky slopes in E. Africa. It differs in shape from all other testudinids, having a flexible, flattened shell, which enables it to squeeze into rock crevices. It feeds mainly on succulents.

Malacocincla *See Trichastoma*.

Malacopterygii Term now little used, describing the group (superorder) comprising the 'lower' bony fish (Osteichthyes), characterized by the possession of only soft-rayed fins (no spines), often one dorsal and often one adipose fin, both dorsal and pelvic fins located roughly midway along the back and belly profile, and the pectorals set low on the body. The 'higher' bony fish are usually grouped as the Acanthopterygii.

Malacostega (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans in which the individuals of the colony possess uncalcified (membranous) body walls anterior to the aperture. The division occurs from the Cretaceous to Recent.

Malacosteidae (loosejaw; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of marine deep-water fish characterized by a very large, low-slung mouth, eyes located far forward on the blunt head, and the dorsal and anal fins placed close to the small tail-fin. There are about 10 species, distributed worldwide.

Malacostraca (phylum Arthropoda, subphylum Crustacea) Class which contains nearly 75% of known crustaceans, including the larger forms, e.g. shrimps, crabs, and lobsters. The typical malacostracan trunk comprises 14 segments and a telson. The thorax is composed of eight segments,

and the remaining six form the abdomen. The first antennae are often biramous, and all the body segments bear appendages. The cutting edge of the mandibles comprises a grinding molar process and a cutting incisor; the mandible usually bears a palp. The carapace is lost in some orders and in most malacostracans one or more of the anterior thoracic limbs is upturned and modified into a maxilliped. Primitively, the biramous thoracic limbs are all similar, with the endopodite better developed than the exopodite, and are used for crawling or grasping. The anterior abdominal limbs are pleopods, and there are usually five pairs. They may be modified for crawling, for creating feeding and respiratory currents, or in the females for egg-carrying. In the males, the first two pairs are usually adapted for use as intromittent organs. The terminal tail-fin, used in swimming, comprises the dorsal telson and a pair of ventral uropods. In the female, the genital openings (gonopores) are on the sixth thoracic segment, while those of the male are on the eighth. The nauplius stage is passed within the egg.

Malapteruridae (electric catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Monospecific family, comprising *Malapterurus electricus* (electric catfish), found in freshwater basins of tropical Africa: there may be a second species in the Congo basin. The massive, stubby body shows an adipose but no dorsal fin. Both adipose and anal fins are located close to the rounded tail-fin. The eyes and spineless pectoral and pelvic fins are small. A large electric catfish can deliver shocks strong enough to stun or kill prey fish. Its electric organs are located under the skin along the whole length of the body.

Malapterurus electricus (electric catfish) *See* Malapteruridae.

malaria Disease of humans caused by various species of the protozoan genus *Plasmodium*. The disease is transmitted by mosquitoes (*Anopheles* species), and varies in severity according to the species of *Plasmodium* responsible. Symptoms typically involve cyclical periods of fever and chills. Recurrence of the disease is common.

malarial mosquito *See Anopheles maculipennis*.

Malayan moon rat (gymnure, *Echinosorex gymnurus*) *See* Erinaceoidea.

Malaysian floral region Part of Good's (1974) Indo-Malaysian subkingdom within his Palaeotropical kingdom, and including the Malay peninsula and archipelago of SE Asia. The flora is one of the richest, if not the richest, in the world. It has yielded many plants of value to humans, of which the banana and various spice plants are perhaps the best known.

mal de caderas Wasting disease of horses and other animals caused by the protozoon *Trypanosoma equinum*. The disease may be fatal. It occurs in S. America.

mal du coit *See* dourine.

Malesian flora Recent term used by some authorities for the tropical flora of Australasia. The name 'Malesia' was introduced to replace 'Malaysia', which was used formerly, and so to distinguish a floral region from the state of Malaysia. It should be restricted to the flora of the islands on and between the Sunda and Sahul shelves, an area comprising Malaysia, Papua New Guinea, and the islands of Indonesia and the Philippines. It is in this sense that the term is used in this dictionary.

malic acid Dicarboxylic acid formed during the citric-acid cycle by the reversible hydration of fumaric acid.

mallard (*Anas platyrhynchos*) *See Anas*.

mallee S. Australian sclerophyllous scrub community, about 2–3 m high, in which most of the species belong to the genus *Eucalyptus*. The scrub is very similar to that found in other continents where Mediterranean type climates occur, e.g. the chaparral of California and the maquis of Europe.

malleus In Mammalia, the outer ossicle of the middle ear, which is derived from the articular bone of ancestral vertebrates.

Mallophaga (chewing lice, biting lice; class Insecta, order Phthiraptera) Group of lice, comprising the suborders Ischnocera, Amblycera, and Rhyncophthirina, all of which possess functional mandibles. The common name 'chewing lice' applied to this group is preferred to 'biting lice' because members of the fourth suborder of lice, the Anoplura, also bite. The use of the Mallophaga as a taxonomic group is to be discouraged because the Rhyncophthirina are more closely related to the Anoplura than they are to the Ischnocera and the Amblycera, and the Ischnocera are more closely related to the Rhyncophthirina and Anoplura than they are to the Amblycera.

Mallotus villosus (Atlantic capelin) *See* Osmeridae.

mallow 1 (*Malva*) *See* Malvaceae. 2 (tree mallow, *Lavatera arborea*) *See Lavatera*.

malmignette *See Latrodectus mactans*.

Malpighiaceae Dicotyledonous family of shrubs, trees, and climbers, with simple, usually opposite leaves which are glandular below or on the leaf stalk. The inflorescence is a raceme with regular or irregular flowers, usually bisexual. The five sepals and five petals are both overlapping. There are 10 stamens; the ovary is superior, of three fused carpels; and the styles are distinct. The fruit is a schizocarp with winged segments, or a fleshy or woody drupe. The seeds contain no endosperm. The family is divided into two tribes, Pyramidotorae and Planitorae, and is thought to be an evolutionary ancestor of the Trigoniaceae and Tremandraceae. It is regarded as a primitive family within the Polygalale group. There are 60 genera, with about 800 species, found mainly in S. America and other tropical regions throughout the world. A number of species are ornamentals.

Malpighian tubules The excretory organs of insects. They are long and narrow, made up of transporting epithelial cells, which join the gut at

the junction of the mid and hind gut. When stimulated hormonally they produce copious amounts of isotonic urine. Their numbers vary greatly from species to species.

maltose Disaccharide comprised of two alpha-glucose units linked by an alpha-1,4-glycosidic bond.

Maluridae (Australian wren; order Passeriformes) Family of small, long-tailed birds; *Malurus* (fairy wrens) have bright blue males, other genera are mainly brown. *Stipiturus* (emu wrens) have only six tail feathers. They are found in grass and scrub, feed on insects, and build a domed nest in grass. There are five or six genera, with 23–30 species, found in Australia and New Guinea. *See also* Ephthianuridae.

Malurus (fairy wrens) *See* Maluridae.

Malus (apples, crabs; family Rosaceae) Genus of usually thorny (in wild forms) deciduous trees. The leaves are simple; the flowers, in umbel-like clusters, are regular with five sepals, five petals, numerous stamens, and 3–5 carpels, which are fused completely with each other and to the receptacle cup. In the fruit (a pome) the receptacle swells to form the flesh of the apple, enclosing the cartilaginous carpel walls. Each carpel contains two seeds ('pips'). In various cultivars they are much grown for their fruit, or for ornament. There are some 25 species, native to the northern temperate zone.

Malva (mallow) *See* Malvaceae.

Malvaceae Family of herbs, with some shrubs and trees. The leaves are palmately veined, often lobed, and rich in mucilage. The flowers are regular, usually pentamerous, with free petals, numerous stamens joined into a tube below, and numerous carpels joined into a ring to form the superior ovary. The fruit is a capsule, or else breaks into many one-seeded nutlets. Cotton is made from the seed-coat fibres of *Gossypium* species; species of *Hibiscus*, *Malva* (mallow), and *Althaea* (especially *A. rosea*, hollyhock), are cultivated for their flowers, while *A. officinalis* (marsh mallow) has been used in confectionery and medicine. In modern classifications there are some 40 genera, with 900 species, occurring in most temperate and tropical regions.

mambas *See Dendroaspis*.

mamma (mammatus) From the Latin *mamma* meaning 'udder', a cloud feature consisting of projections from the basal surface of altocumulus, altostratus, stratocumulus, cumulonimbus, cirrus, and cirrocumulus. *See also* cloud classification.

Mammalia (kingdom Animalia, subkingdom Metazoa, phylum Chordata, superclass Gnathostomata) Class of homoiothermic animals in which the head is supported by a flexible neck, typically with seven vertebrae, articulating through two occipital condyles; the side wall of the skull is formed by the alisphenoid bone; the lower jaw is formed from the dentary bone and articulates with the squamosal; the quadrate and articular bones form auditory ossicles and the angular bone forms the tympanic bone; typically teeth are present and are thecodont, heterodont, and diphyodont; the buccal cavity is separated by a hard palate from the nasal cavity; and epiphyses are present on many of the bones. The thorax and abdomen are separated by a diaphragm; the heart is four-chambered; the right aortic arch is absent; except in monotremes the egg is small and develops in the uterus; and the young are fed milk secreted by mammae (which give the class its name). The skin has at least a few hairs. Many mammalian features were present in therapsids (mammal-like reptiles) during the Triassic. Mammals are believed to have appeared first toward the end of the Triassic and to have diversified rapidly from the end of the Mesozoic, 100 million years later, following the mass extinction which marks the Mesozoic–Tertiary boundary 65 million years ago.

mammary gland In female mammals, a gland on the ventral surface which produces milk. It is probably derived from modified sweat glands.

mammatus *See* mamma.

Mammea (family Guttiferae) Genus of small, evergreen trees, whose flowers have sepals that are fused, later splitting with two valves, usually four petals, and many stamens. The fruit is a drupe (sometimes edible). There are 50 species, with a pantropical distribution centred on SE Asia.

mammillated topography Hill relief with a streamlined, rounded, and smoothed appearance, normally resulting from the scouring action of an ice sheet, as in the Adirondack Mountains, eastern USA. However, some crystalline rocks may support a pseudo-mammillated surface formed by non-glacial processes, as on Ben Lomond, Tasmania.

mammoth *See Mammuthus*; and Elephantidae.

Mammuthus (mammoth) Line of Pleistocene elephants adapted to steppe and tundra habitats. The tusks were elongated and strongly curved, and the skull was shorter and higher than that of other elephants. The woolly mammoth was adapted to arctic environments. The largest mammoth, indeed the largest probiscidean of all time, was *Mammuthus armeniacus* of Eurasia, which stood about 4.5 m at the shoulder.

Mammutidae (Mastodontidae; order Hyracoidea, suborder Mammutoidea) Extinct family of mastodons, comprising the one genus *Mammut* (*Mastodon*) of elephant-like animals, which diverged from the evolutionary line leading to the modern elephants. It was long-lived, extending from the Lower Miocene to the Recent, and it survived in Africa and the Holarctic region at least until the end of the Pleistocene. Mastodons were shorter and heavier in build than elephants. *Mammut* (or *Mastodon*) species had short, high skulls, longer jaws than elephants, and usually tusks in both upper and lower jaws, the upper tusks often being large and curving outward and upward. There were never more than two teeth in use at a time, never more than a vestige of the lower incisors, and the molars were low-crowned, simple, and lacked

cement. It is believed that the evolution of the mastodons paralleled that of the gomphotheres.

Mammutoidea (superorder Paenungulata, order Hyracoidea) Suborder that includes the families Mammutidae (Mastodontidae) and Stegodontidae, the mastodons and the primitive true elephants.

man *See Homo*; *Homo erectus*; *Homo habilis*; *Homo sapiens neanderthalensis*; *Homo sapiens sapiens*; and Hominidae.

manakins *See Pipra*; and Pipridae.

manatee (*Trichechus*) *See* Trichechidae.

mandible In Crustacea, insects, and Myriapoda, one of the pair of mouth-parts most commonly used for seizing and cutting food. In birds, specifically the lower jaw but the term is also used to denote the two parts of the bill of a bird, as upper and lower mandibles.

mandioca (cassava) *See Manihot*.

mandrill (*Mandrillus*) *See* Cercopithecidae.

Mandrillus (mandrill) *See* Cercopithecidae.

maned wolf (*Chrysocyon brachyurus*) *See* Canidae.

manganese (Mn) Element which is required in small amounts by plants. It is involved in the light reactions of photosynthesis and also binds to proteins. The leaves of manganese-deficient plants show interveinal chlorosis and may become malformed.

manganese nodule Concretion of iron and manganese oxides which also contains copper, nickel, and cobalt. Nodules are variable in size, shape, and composition, and are layered internally. The average composition is: manganese 30%; iron 24%; nickel 1%; copper 0.5%; cobalt 0.5%. Manganese nodules are widely distributed on the sea-floor of every ocean and in some temperate lakes. They are found in areas of negligible sedimentation and/or strong bottom currents, e.g. on the N. Pacific abyssal plain at depths of 3500–4500 m, and on the shallow current-swept Blake Plateau off the east coast of the USA. Submarine mining of these deposits is now considered viable to recover copper and other scarce metals. Growth of manganese nodules apparently reached a peak in the early Tertiary period.

manganite Mineral, specific gravity 4.2–4.4, hardness 3.0–4.0, and with the chemical composition $MnO_2Mn(OH)_2$. It occurs in deposits precipitated in sedimentary conditions in which there is an oxygen deficiency. It also occurs in low-temperature hydrothermal veins in association with barite and goethite. It is distinguished by its colour, prismatic habit with striated crystal faces, and its solubility in hydrochloric acid with the evolution of chlorine. It is dark steel-grey to black, and has a reddish-brown to black streak, and a sub-metallic lustre. It crystallizes in the monoclinic system. The crystals are prismatic with striated faces, and also occur as bundles or radiating aggregates. It is often used in steel-making.

Mangifera (family Anacardiaceae) Genus of small to large evergreen trees, which have simple leaves borne spirally in tight terminal clusters; these leaves are red when young. The fruit is a drupe, variously fibrous, and that of several species is edible (mangoes). *M. indica* is widely cultivated throughout the tropics. The timber is an attractive dark brown with blackish markings. There are about 30 species, native to tropical Asia.

Manglietia (family Magnoliaceae) Genus of evergreen trees, which are like *Magnolia*, but have four ovules rather than two per carpel. There are 30 species occurring in SE Asia.

mango 1 (*Mangifera indica*) *See Mangifera*. 2 *See Anthracothorax*.

mangosteen (*Garcinia mangostana*) *See Garcinia*.

mangrove forest Swamp forest developed on tropical and subtropical tidal mud-flats, particularly in quiet creeks and estuaries. Characteristically, mangrove forest is low and dense with a tangle of aerating roots projecting above the mud. Occasionally, substantial, lofty trees occur in the mangrove interior.

mangrove jack (*Lutjanus argentimaculatus*) *See* Lutjanidae.

mangrove swamp Characteristic vegetation of tropical, muddy coasts, and typically associated with river mouths where the water is shallow and the load of suspended sediment is high. The aerial roots of the mangrove trees trap the sediment, favouring the gradual seaward extension of the land area.

Manidae (pangolins, scaly ant-eaters; cohort Unguiculata, order Pholidota) Family of animals which are similar superficially to the New World ant-eaters, to which they may be related distantly. Pangolins (or scaly anteaters) are nocturnal, insectivorous, terrestrial, or arboreal mammals up to 1.5 m long, lacking teeth, with elongated snouts, and tongues that are long, thin, and sticky. There are long claws on all five digits of each limb. The tail is long and prehensile in arboreal species. The dorsal surface of the body is covered with overlapping epidermal scales, and a manid will roll itself into a ball when threatened. The eyes and ears are small, the stomach simple. The brain is very small, the hemispheres folded. There is one genus, *Manis*, and several species, distributed throughout the Old World tropics except for Madagascar and Australia.

Manihot (family Euphorbiaceae) Genus of shrubs and herbs which produce white latex. The leaves are deeply palmately lobed. *M. esculentia* (*M. utilissimus*) provides cassava (manioc) from swollen tubers which in many varieties have a high cyanide content. *M. glaziovii* is a small tree whose latex provides ceará rubber. There are 170 species, occurring from the south-west of N. America to tropical America.

Manila copal *See Agathis*.

Manila hemp *See* abacá.

Manilkara (family Sapotaceae) Genus of evergreen trees, including *M. zapota* (or *Achras zapota*), which

is native to S. America and now widely cultivated. It yields the delicious, edible fruit known as zapote or, in the East, chiku. There are about 75 species, occurring throughout the tropics.

man-induced turnover The additional flow of an element through the active part of a biogeochemical cycle that results from human activity. For example, by burning fossil fuels humans add an extra 5×10^9 tonnes per year of carbon to the turnover of the carbon cycle which is naturally about 75×10^9 tonnes per year.

manioc *See Manihot*

mannan Polysaccharide composed mostly of glycosidically-linked mannose units. These are storage polymers in some species and perform a structural role in others. A great range of linkage has been reported and some mannans also contain other sugars.

mannikins *See* Estrildidae; and *Lonchura*.

mannitol Polyhydroxy alcohol, which can be synthesized chemically by the reduction of mannose. It is found in many higher plants and in some algae.

mannose Aldohexose monosaccharide, which occurs in a wide variety of organisms including vegetable gums, fungi, bacterial capsular layers, and some immunoglobulins in animals.

man o'war fish (*Nomeus gronovius*) *See* Nomeidae.

manta *See* Mobulidae.

Manta birostris (giant manta) *See* Mobulidae.

Mantidae (praying mantids; class Insecta, order Mantodea) Family of medium to large, cryptically coloured, predatory insects, which comprise by far the larger of the two families of praying mantises. The 1800 or so described species are found in all the warmer parts of the world. For a fuller description of mantid characteristics, *see* Mantodea.

mantid flies *See* Mantispidae; and Neuroptera.

mantids *See* Mantidae; *Mantis religiosa*; and Mantodea.

Mantispidae (mantid flies; subclass Pterygota, order Neuroptera) Family of insects whose common name refers to their mantid-like appearance. The prothorax is elongate, with raptorial forelegs arising from its anterior end. The predacious adults have large, transparent wings, up to 35 mm in span. The larvae are parasites on the egg sacs of wolf spiders, and one subfamily is parasitic in the nests of vespoid wasps. Mantispids are widely distributed, but are commoner in southern regions.

Mantis religiosa (praying mantis; order Mantodea, family Mantidae) Species of insect which exemplifies the praying mantids. It is green, about 7 cm long as an adult, and lies in wait for its prey with the grasping forelegs held in a position that suggests an attitude of prayer. The insect occurs in Europe.

mantis shrimps *See Squilla mantis*; and Stomatopoda.

mantle 1 Zone lying between the Earth's crust and core, approximately 2300 km thick. Compositionally the mantle is probably similar to garnet peridotite and it represents about 84% of the Earth's volume and 68% of its mass. 2 *See* Cirripedia.

mantle lobe *See* Brachiopoda.

Mantodea (mantids, praying mantises; class Insecta) Order of medium to large, terrestrial insects which are predacious, having large, raptorial forelegs used for seizing their insect prey. The prothorax is usually narrow and elongate (unlike that of the Phasmatodea), and the head is typically triangular and freely movable on a slender neck. The mantids are exopterygote but, unlike those of the Orthoptera, the wing buds do not reverse their orientation in later instars. The forewings are narrow, and may be hardened as tegmina. The females of many species have reduced wings. Eggs are laid in an ootheca. About 1800 species of mantids have been described, and are found in the warmer regions of the world.

manubrium 1 In Coelenterata, a projection around the mouth. 2 In Collembola, the single, basal portion of the furcula, which bears a pair of structures called dens.

many-plumed moths *See* Alucitidae.

map butterflies *See* Nymphalidae.

maquis (Italian *macchia*; Spanish *matorral*). French term for drought-resistant Mediterranean scrub, taller than garrigue, and composed of evergreen shrubs and small trees with thick, leathery leaves (sclerophylls), or spiny foliage, e.g. *Olea europaea* (wild olive), *Cistus* species (cistus), *Erica* species (heather), and *Genista* species (broom). For the most part this sclerophyllous formation has been derived by a combination of burning and grazing from the original mixed evergreen Mediterranean forest. *See also* Mediterranean scrub.

Maranta (family Marantaceae) Genus of herbs, including *M. arundinacea*, whose rhizomes provide W. Indian arrowroot. There are 23 species, occurring in tropical America.

Marantaceae Family of herbs most of which have rhizomes or tubers. The petiole base is sheathing, and kneed at the top; the leaves pinnately nerved. The inflorescence is subtended by a large bract. The flowers are hermaphrodite, zygomorphic, and trimerous, with one stamen; they are epipetalous; the ovary is inferior; the fruit is a capsule or berry. Marantaceae are related to Musaceae. There are 30 genera, with 350 species, occurring in the tropics, mainly in America.

Marasmius (family Tricholomataceae) Genus of fungi in which the fruit bodies are mushroom-like and are usually small; they shrivel on drying but revive when moistened. The cap is typically tough and pliable, and the gills are usually well-spaced. Species grow in clusters or rings on the ground in grassland, woodland, etc. *See also* fairy ring.

Marattiaceae Family of large, primitive, eusporangiate ferns. Fossils which clearly belong in this family have been found in the Carboniferous rocks. At present there are about seven genera, widely distributed in the humid tropics.

marble Non-foliated, metamorphosed limestone which is produced by recrystallization and is hard enough to take a polish. Marbles may be variously coloured, depending on their chemical and mineralogical composition.

marbled murrelet (*Brachyramphus marmoratus*) *See* Alcidae.

marbled newt *See Triturus marmoratus*.

marbled white butterflies *See* Satyrinae.

Marburg agent RNA-containing virus of uncertain classification, which was first reported in 1967, when it was isolated from patients with a severe disease known as green-monkey fever.

marcasite Mineral, specific gravity 4.8–4.9, hardness 6.0–6.5, chemical composition FeS_2, whose name is derived from the Arabic word for 'pyrite'. It occurs in low-temperature mineral veins together with zinc and lead ores, and also in sedimentary rocks, especially limestone, chalk, and clay. It is distinguished by its pale colour, spear-shaped crystals, and low specific gravity. It is pale bronze-yellow, and has a greyish-black streak, and a metallic lustre. It crystallizes in the orthorhombic system. The crystals are tabular and spear-like, but it is also massive, stalactitic, and radiating. It has been used in the production of sulphuric acid.

Marchantia (order Marchantiales) Genus of thallose liverworts. *M. polymorpha* is a common species in Britain. It is immediately recognizable by the presence on the upper surface of symmetrical, cup-shaped structures containing small discoid gemmae. The plant is particularly conspicuous when fertile; the male reproductive structures resemble miniature mushrooms, while the female structures are stalked with many radiating, spoke-like lobes at the top of the stalk. *Marchantia* are common in gardens, on paths, flower-pots, etc., and are also found on moors, heaths, river banks, etc.

Marchantiales (class Hepaticae) Order of thallose liverworts in which the thallus is generally flat and ribbon-like, and branched by simple, regular forking. The upper surface is green. Within the thallus are air chambers (areolae) which open to the surface via pores which may or may not be visible to the naked eye. Rhizoids on the lower surface attach the plant to a substrate and absorb water and mineral salts. Marchantiales are found mainly in damp habitats on a variety of substrates.

March flies *See* Bibionidae.

mares tail (*Hippuris vulgaris*) *See* Hippuridaceae.

mares' tails Popular name for tufted cirrus clouds with virga (precipitation trails) seen below each cloud.

marginal sea Semi-enclosed body of water adjacent to, and widely open to, the ocean, e.g. the Gulf of Mexico, the Caribbean Sea, and the Gulf of California.

Mariametracea (feather-stars; subclass Articulata, order Comatulida) Superfamily of feather-stars in which the centrodorsal plate is low, with a hemispherical to discoidal shape. The dorsal surface does not bear cirri, and is flat or slightly concave. The radial plates bear flat, low articulation surfaces. The superfamily is known from the Eocene to Recent.

mariculture Intensive fish-farming in marine or estuarine waters, involving additions of nutrients, energy, and stock. It is the marine equivalent of aquaculture, and provides an important food supplement for humans in some areas, notably Japan and Indonesia. It is little practised elsewhere, although it has considerable potential. The organisms farmed are predominantly shellfish, especially clams, mussels, and oysters.

marijuana (*Cannabis sativa*) *See Cannabis*.

marine iguana *See Amblyrhynchus cristatus*.

marine regression *See* regression.

marine toad *See Bufo marinus*.

maritime air Air mass with properties of temperature and humidity derived from a source region in, or from long passage over, the oceans.

maritime climate General term applied to a climate much modified by oceanic influences. Typical characteristics include relatively small diurnal and seasonal temperature variation, and increased precipitation due to more moist air.

mark–recapture technique Technique for estimating the population density of more elusive or mobile animals. A sample of the population is captured, marked, and released. Given that these marked individuals become randomly distributed through the wild population, and that subsequent trapping is random, any new sample should contain a representative proportion of marked to unmarked individuals. From this, the size of the population (P) may be estimated, most simply by dividing the number in the sample recaptured (n_r) by the product of the number of marked individuals in the recaptured sample (n_{rm}) multiplied by the number of individuals originally marked (n_{om}). This calculation (the Lincoln index) $P = n_r \div n_{rm} \times n_{om}$, is appropriate only when the population is fairly static or where changes—due to migration, natality, or mortality—are known. When a population is fluctuating rapidly, as is common in insect populations, more sophisticated indices, which allow for the probabilities of change, are preferable.

marl Lime-rich clay, usually found as an alluvial deposit and containing a high proportion of soft calcium carbonate.

marlin *See* Istiophoridae.

marmoset *See* Callitrichidae.

marmot (woodchuck, *Marmota marmota*) *See* Sciuridae.

Marmota marmota (marmot, woodchuck) *See* Sciuridae.

marsh More or less permanently wet area of mineral soil, as opposed to a peaty area, e.g. around the edges of a lake, or on an undrained river flood-plain. Colloquially, 'marsh' is often used interchangeably with 'swamp' and 'bog'.

marsh fern (*Thelypteris thelypteroides*) *See* Thelypteridaceae.

marsh frog *See Rana ridibunda*.

marsh mallow (*Althaea officinalis*) *See Althaea*; and Malvaceae.

marsh wrens *See Cistothorus*.

marshy tundra Marshy tracts found as important components in the low-, middle-, and high-arctic tundra belts, because drainage is frequently poor as a result of the widespread presence of permanently frozen ground at no great depth. Grasses, sedges, and dwarf willows are the most prolific vascular plants of marshy tundra, often accompanied by luxuriant growths of moss.

Marsileaceae Family of highly specialized aquatic or semi-aquatic ferns. The rhizomes bear alternate leaves which are either cylindrical and taper to a point, e.g. *Pilularia*, or bear two or four broad leaflets at their tips, e.g. *Marsilea* and *Regnelidium*. The sporangia are of two kinds, megasporangia and microsporangia, and are borne in globose, hairy sporocarps at the base of the leaf stalks; two or more sori occur in each sporocarp, and each sorus contains both types of sporangium. There are three genera, two of which are almost cosmopolitan, and some 70 species.

Marsipobranchii Alternative name for Cyclostomata (Agnatha).

marsupial ant-eater *See* Myrmecobiidae.

marsupial carnivores *See* Dasyuridae.

marsupial frog *See Gastrotheca marsupiatum*.

Marsupialia (subclass Theria, infraclass Metatheria) Order comprising some 250 species of living marsupials and many extinct forms. It is sometimes divided into three suborders: Polyprotodonta, which includes the opossum-like insectivorous, carnivorous, and omnivorous forms; Diprotodonta, containing the phalangers, kangaroos, and other forms evolved from an opossum-like stock, but differing structurally from the polyprotodonts; and Caenolestoidea (classed by others as a superfamily), containing a small group of 'opossum-rats'. Marsupials are characterized principally by their method of reproduction. The egg is yolky and has a thin shell protecting it from maternal antigens. Placental development is usually very limited and except in *Perameles* the allantois serves no nutritional function, but uterine milk may be taken up by the yolk sac. Within 10–12 days of the breaking of the shell, the embryo—whose forelimbs and associated neural development, mouth, and olfactory system have developed precociously—is born. It crawls into the pouch (marsupium) and attaches itself to a teat, its lips growing around the teat, which injects milk without choking the embryo. In the later stages of its development an offspring may receive high-fat, low-protein milk from one teat while a newer embryo receives high-protein, low-fat milk from another. Marsupials also differ from placentals in their dentition, in the possession of an inflected angular process to the jaw, and in the presence of two marsupial bones which articulate with the pubes. Marsupials and placental mammals apparently diverged from a common ancestor in the Cretaceous. The first marsupials were similar in general form to the opossums of America. In Australia the marsupials radiated to produce a wide array of adaptive types, while in S. America they filled the insectivorous and carnivorous niches for much of the Cenozoic, while placentals occupied the herbivorous niches.

marsupial mice *See* Dasyuridae.

marsupial mole *See* Notoryctidae.

marsupial pouch *See* marsupium.

marsupial rats *See* Dasyuridae.

marsupium In many female Marsupialia and *Echidna*, a fold of skin supported by epipubic bones containing the mammary glands into which the eggs of *Echidna* and young of marsupials are placed.

marten (*Martes*) *See* Mustelidae.

Martes martes (pine marten) *See* Mustelidae.

martin bug *See Oeciacus hirundinis*.

martins 1 *See Delichon*; Hirundinidae; and *Hirundo*. 2 (sand martins) *See Riparia*.

Martyniaceae (unicorn plants) Dicotyledonous family of herbs with tuberous roots, known as 'unicorn plants' because of their horned fruits. Characteristically, the plants are covered in sticky hairs, and have simple opposite or alternate leaves and no stipules. The terminal inflorescence is composed usually of showy flowers which are two-lipped. The corolla is cylindrical, or funnel- or bell-shaped, and the stamens are attached. The ovary is superior with a basal nectar disc, two fused carpels, and one locule. There is a single style and a forked stigma, which is sensitive to touch. The fruit is a capsule, with the persistent style forming a horn or hooked projection which is a useful aid to dispersal by animals. The seeds are compressed with a straight embryo and no endosperm. Some species are cultivated for their unusually shaped fruits, which can be pickled and eaten. The family is related to the Bignoniaceae. There are three genera, with 13 species, found mainly in tropical and subtropical America.

Masaridae (suborder Apocrita, superfamily Vespoidea) Family of medium-sized (9–24 mm long), stout-bodied wasps, which are often strongly marked with orange. They are sometimes regarded as a subfamily of the Vespidae, but should be excluded from that family on the basis of the relatively weak wing coupling, the possession of two submarginal wing cells (vespids have three), and other structural features. The antennae are clubbed, and the mandibles do not cross over. Single nests or groups of nests are provisioned with pollen and nectar, and are constructed of mud or sand attached to rocks or twigs.

mask (labial mask, labium) Organ formed from the labium, and found only in the nymphs of the insect order Odonata: it is so named because it covers the mouthparts, and sometimes the face. It is prehensile, and nymphs use it to capture prey by

extending it at high speed and impaling the prey on the terminal spikes, or by trapping prey in a basket formed by the mask and its associated bristles.

mason bee Any member of the genera *Anthocopa*, *Chalicodoma*, *Dianthidium*, *Heriades*, *Hoplitis*, or *Osmia*, of the cosmopolitan family Megachilidae. The female collects soft, malleable building materials which are shaped at the nest site into durable structures. The nests may be inside existing cavities in timber, under stones, or may be built on exposed surfaces, e.g. rocks, or leaves and branches of woody plants. According to the bee species, the collected materials may be mud, pebbles, quartz chips, resin, or a mastic of chewed leaves or petals, or a combination of two or three of these substances.

mason wasps *See* Eumenidae.

masseter muscle In animals, one of the muscles that raise the lower jaw.

mass flow Movement of solvent and solute molecules in a solution from one compartment to another, the rate being dependent on the hydrostatic pressure gradient and the resistance offered by the connecting pore. This concept is important in theories of translocation in plants.

massive hydrocorals *See* Milleporina.

mass provisioning The provision of all the food required for larval development by wasps and bees. The food, either insect or spider prey (for wasps) or honey and pollen (for bees) is stored in a specially prepared space (cell) within the nest. An egg is laid on or in the food, and the cell is sealed. Mass provisioning is very largely found in solitary (non-social) species, but is also practised by the highly social stingless bees.

mass spectrometry Technique that allows the measurement of atomic and molecular masses. Material is vaporized in a vacuum; ionized; and then passed first through a strongly accelerating electric potential, and then through a powerful magnetic field. This serves to separate the ions in order of their charge : mass ratio; detection is commonly made using an electrometer, which measures the force between charges and hence the electrical potential.

mass-wasting General term for the transfer of earth material down hillslopes. It includes four main categories: flow, slide, fall, and creep. Of these, the last is the most important if least spectacular. Creep is the result of gravity acting on material that has lost cohesion, typically as a result of an increase in water content. An 'avalanche' is a rapid and often destructive flow of rock or snow. A slide (or 'landslide') is a comparatively rapid displacement of earth material over one or more failure surfaces which may be curved or planar. Failure on an arcuate surface is typical of clays, and gives rise to rotational slides such as those of Folkestone Warren, England.

mast Fruit of beech, oak, and other forest trees, often used as a food for pigs.

Mastacembelidae (spiny eel; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of freshwater fish which have very elongate, eel-like bodies. The dorsal fin consists of a series of short spines followed by a long second dorsal fin matched by the anal fin. Typically, the pointed snout terminates in long, fleshy, tubular nostrils, probably used by these nocturnal fish to sniff out food in darkness. They are sometimes kept in aquariums, although *Mastacembelus armatus* may grow to 1 m in length. About 50 species are found in tropical Africa and Asia.

mast cell Connective tissue cell that on becoming injured at a site of tissue damage releases certain chemicals. Some of these cause a restriction of lymph vessels, thus allowing localized swelling to occur. Another, called histamine, increases capillary permeability, allowing leucocytes to leave the circulatory system more readily and to congregate at the site of injury.

master chronology Average tree-ring chronology for a particular region, or derived locally from a number of closely matching individual tree-ring chronologies. The master chronology forms the reference against which new ring series may be compared and dated.

Mastigomycotina (division Eumycota) Subdivision of fungi which form motile (flagellated) cells called zoospores. The subdivision contains three classes.

Mastigophora (subphylum Sarcomastigophora) Superclass of protozoa, which employ one or more flagella for locomotion; There are two classes, and 19 orders. The superclass includes a wide variety of organisms, many of which are classified alternatively with the algae.

Mastigoproctus giganteus (vinegaroon; class Arachnida, order Uropygi) The largest known species in the order Uropygi, which attains a length of 7.5 cm. It occurs in N. America.

mastodon (*Mammut*, *Mastodon*) *See* Mammutidae.

Mastodontidae *See* Mammutidae.

mastoid process In animals, a bony outgrowth behind the ear: it contains air spaces which communicate with the middle ear.

Mastotermitidae (order Isoptera) Family of lower termites containing only one surviving species, *Mastotermes darwiniensis*, which inhabits N. Australia. Colonies may contain one million inhabitants, living in many underground nests connected by covered passages built along the surface of the ground. Their very catholic diet makes them extremely destructive.

matamara *See Chelus fimbriatus*.

maté *See Ilex*.

maternal message Messenger-RNA synthesized during oogenesis and deposited in the egg cytoplasm, with ribosomes, as an inactive complex often termed an 'informosome'. It is activated after fertilization and helps to control the earliest stages of development.

mating Union of two individuals of opposite sexual type to accomplish sexual reproduction.

mating type Equivalent in lower organisms (particularly micro-organisms) of sexes in higher organisms. Micro-organisms may be subdivided into mating types on the basis of their physiology and mating behaviour. Different mating types are usually identical in physical form although individuals of one mating type possess on their surfaces proteins that will bind to complementary proteins or polysaccarides found only on the coats of individuals of the opposite mating type. In this way, only individuals of different mating types will undergo conjugation.

Matoniaceae Family of ferns, whose fronds, which are borne on rhizomes, have a characteristic dichotomous branching which produces a fan-like form. The sori are gradate, superficial, rounded, and on the under-side of the pinnae; unlike the related Gleicheniaceae, they have rounded indusia. The anatomy of the rhizome is a complex solenostele, with several concentric cylinders of vascular tissue. There are two genera, with four species.

matorral *See* maquis.

matrix Lithological or petrological term denoting the interstitial material lying between larger crystals, fragments, or particles. It is the background material of small particles in which larger particles and fragments occur. *Compare* groundmass.

matrix support Texture of sedimentary rocks which denotes the complete separation of larger fragments or clasts from the finer-grained matrix.

mature phase Stage in the cyclical pattern of community change in grasslands and heathlands. In grasslands, the mature phase is the stage in which the grass hummocks attain their maximum height (about 4 cm) and begin to be colonized by lichens. In heathlands, it is the stage at which *Calluna vulgaris* bushes, about 12–18 years old, start to become less dense, allowing other species, especially bryophytes, to grow. *Compare* building phase; pioneer phase; hollow phase; and degenerate phase.

Mauritia (family Palmae) Genus of big fan palms which are dioecious (female with some hermaphrodites). The paniculate inflorescences are borne among the leaves. The fruits are scaly. *M. flexuosa* of swamp forest provides useful fibre. There are 21 species, found in tropical S. America.

Maxburretia (family Palmae) Genus of fan palms which grow in small clumps. Male and hermaphrodite flowers occur in panicles on different plants. The flowers are fragrant, and have three free carpels. The fruits are thinly fleshy. There are three isolated species, each restricted to a few limestone hills in the Malay peninsula.

maxilla 1 In vertebrates, the posterior bone of the upper jaw, which bears the teeth other than the incisors. The term is sometimes applied to the whole of the upper jaw. 2 In some arthropods, one of a pair of mouthparts used in eating. *See also* maxillary palp.

maxillary gland *See* Crustacea.

maxillary palp Jointed, sensory structure found on the maxillae of an insect. The maxillae are paired, limb-like structures located immediately behind the mandibles, which articulate with the head capsule.

maxillopalatine Part of the upper jaw of some avian orders, which distinguishes them structurally from others. It consists of a plate formed by the fusion of the two maxillopalatine bones.

maximum sustained yield (MSY) *See* optimum yield.

maximum thermometer Thermometer that records the highest temperature to which it has been exposed, e.g. by allowing a rise of mercury past a restriction in the tube, but preventing the mercury's return on contraction. It is most commonly used to record maximum daily temperatures.

maximum velocity of enzyme Maximum rate at which a given quantity of enzyme can catalyse a reaction under defined conditions. It is achieved only when the enzyme is saturated with substrates and cosubstrates.

May apple *See Podophyllum*.

maybug (cockchafer, *Melolontha melolontha*) *See* Scarabaeidae.

Mayetiola destructor (hessian fly) *See* Cecidomyidae.

mayflies *See* Ephemerellidae; Ephemeridae; and Ephemeroptera.

mazaedium Type of ascocarp in which the ascocarp contents (asci, paraphyses, etc.) disintegrate to form a powdery mass.

meadow frog *See Rana pipiens*.

meadow grasses *See Poa*.

meadow-steppe A variant of Eurasian steppe adjacent to the forest to the north, and comprised primarily of various sod-forming grasses and subordinate tussock grasses. The grasses grow to over a metre, and associated with them are broad-leaved flowering herbs, the whole giving a meadow-like aspect in summer. Meadow-steppe has long been greatly reduced in extent by agricultural practices.

meagre (*Argyrosomus regius*) *See* Sciaenidae.

meal-worm (*Tenebrio molitor*) *See* Tenebrionidae.

mealybug *See* Coccidae.

mealy hairs Hairs which collectively have the consistency of meal and give the appearance of a mealy covering.

meander Sinuous, regular trace of a river channel. The geometric properties (e.g. the ratio between the wavelength and the channel width) are remarkably constant irrespective of size. Its origin is still unclear, but the meander curve may be the shape that is most suited for the uniform expenditure of energy. If relative uplift of the land occurs, an incised or entrenched meander may occur.

mean sea-level The average height of the surface of the sea, for all stages of the tide, over a long (usually

19-year) period, being determined from hourly readings of tidal height.

mean square (variance) The square of the mean variation of a set of observations around the sample mean.

measles (morbilli, rubeola) Acute, infectious disease which affects mainly children; other primates can also be affected. Symptoms begin with cough and cold-like symptoms, and these are followed by fever and skin rash. In healthy children the disease is usually mild and self-limiting, but in undernourished children it can be fatal. It is caused by a paramyxovirus.

mechanical senses Senses that detect mechanical stimuli, e.g. touch, hearing (detecting air vibration), and balance.

mechanized dandruff (*Pediculus capitis*) *See* Pediculidae.

medaka (*Oryzias latipes*) *See* Oryziatidae.

medial moraine *See* moraine.

median fin One of the unpaired fins of sharks and bony fish, including the dorsal, anal, and tail fins.

medieval woodland Woodland that is known to have existed prior to the seventeenth century. Some authorities use 1600, others 1650, as the base-date. *See also* ancient woodland.

mediocris From the Latin *mediocris* meaning 'medium', a species of cumulus with limited vertical development and characterized by very slight projections on the upper surface. *See also* cloud classification.

mediolittoral Applied to that area of a shore that is approximately equivalent to the intertidal or littoral zone, but excluding the lowermost reaches that are uncovered for only very limited periods. The term is used in an alternative system for subdividing the near-shore area of marine ecosystems. *Compare* infralittoral; and circalittoral; *see also* littoral zone.

Mediterranean chameleon *See Chamaeleo chamaeleon.*

Mediterranean climate Distinctive climatic type, which occurs around latitude 35° N and 35° S, and which is associated with warm-temperate west coasts. Summers generally are hot and dry, winters mild to cool and rainy. The climate is strongly influenced by westerly airstreams in winter, and subtropical high pressure in summer. In the type area, the Mediterranean basin, there is a variety of climatic regimes owing to the complex configuration of seas and mountainous peninsulas in the 3000 km incursion into Eurasia. Annual rainfall is broadly 500–900 mm, but less in more continental locations. Other areas of this type include the coasts of Chile in corresponding latitudes, S. California, SW Africa, and SW Australia. Cool ocean currents offshore bring lower temperatures to parts of the Chilean and Californian coasts, but rainfall and temperatures are much affected by the differences of slope and elevation inland.

Mediterranean floral region Part of Good's (1974) Boreal kingdom, and geographically a relatively small region, being restricted to Iberia and the Mediterranean littoral, but with an important extension northward along the western coast of Europe. The vegetation is specialized, reflecting the distinctive climatic setting, and consequently contains a high proportion of endemics. The Mediterranean has been called 'the cradle of civilization' and the long association with mankind has yielded many garden, horticultural, and agricultural plants.

Mediterranean forest The climatic climax of most of the Mediterranean basin, now virtually destroyed and over vast areas replaced by garrigue and maquis. The trees were evergreen, both conifers and broad-leaved hardwoods. They were probably mixed, but there may well have been segregations of the two types.

Mediterranean scrub Two principal varieties are recognized on the basis of the stature of the constituent shrubs. The tall variety is called maquis, the short variety garrigue; but the distinction is somewhat arbitrary and there are many intergrade types. Both occupy vast areas and were derived by burning and grazing from an earlier forest cover. Indeed, constant use of fire has created distinctive plant associations within the scrub, such as the 'giane' (rosemary and *Genista* species) and 'ericeto' (tree heath) in southern Italy. In Iberia such associations are even more extensive and include the 'brezales' (heathers), 'jorales' (*Cistus* species), 'goscojales' (*Quercus coccifera*, kermes oak) and 'bujedales' (*Buxus sempervireus*, box).

medlar *See Mespilus.*

medulla 1 In cylindrically-stemmed plants, the pith or central part. 2 The central part of an organ or bone (i.e. the marrow). 3 In vertebrates the term is often used as an abbreviation of medulla oblongata, the most posterior part of the brain linked directly to the spinal cord. It is primitively concerned with the processing of sensory information and contains centres controlling many involuntary functions.

Medusina mawsoni An early jellyfish. During the uppermost Precambrian, beach deposits laid down in the Ediacara Hills of S. Australia were covered by a layer of fine muddy sediments. The result was the unique preservation of numerous soft-bodied organisms including the early jellyfish *Medusina mawsoni* and *Medusinites*.

Megachile *See* leaf-cutter bee; and Megachilidae.

Megachile rotundata (alfalfa leaf-cutter bee) *See* Megachilidae.

Megachilidae (mason bees, leaf-cutter bees, carder bees; order Hymenoptera, suborder Apocrita) Large, cosmopolitan family of solitary bees, in which the pollen scopa consists entirely of tracts of stiff hairs on the abdominal sterna. The labrum is longer than it is broad, and basitibial and pygidial plates are absent. The family includes the mason bees and leaf-cutter bees, and also such genera as *Anthidium* and *Callanthidium*, the females of which tease out (card) plant hairs to use as nest-lining material—hence the common name 'carder bees'.

Nests are usually made in pre-existing cavities, e.g. in beetle borings in dead wood or pithy stems. Some species specialize in using old snail shells; others build exposed nests on rocks, woody branches, etc. One species, *Megachile rotundata*, is cultured commercially in the western USA as a pollinator of *Medicago sativa* (alfalfa or lucerne).

Megachiroptera (flying foxes, fruit bats; cohort Unguiculata, order Chiroptera) Suborder of large bats, with a wing-span of up to 1.5 m, which roost in colonies in trees, often feed in large groups, emit loud cries, and orientate by sight and smell, not by echo-location (except in one genus, *Rousettus*). Most feed on fruit. The snout is long, the teeth are flattened for grinding, the tail lies below the uropatagium and is not part of it, and the second digit of each forelimb has three joints and a claw. Megachiropterans retain certain primitive features in the skull and are less specialized than microchiropterans. The suborder comprises only one family, Pteropodidae, containing about 45 genera, with more than 170 species, distributed throughout the Old World tropics and subtropics.

Megachytriaceae (order Chytridiales) Family of fungi in which zoospores are released from the sporangium via an opening previously covered by a lid or operculum. The thallus is polycentric. They are saprotrophic, and found in soil and water.

Megadermatidae (false vampires; order Chiroptera, suborder Microchiroptera) Family of bats, in which the ears are large, and joined extensively, and have a tragus that is very large; in which the eyes are relatively large; and in which the nose has a well-developed leaf, often concealing the nostrils. The uropatagium is not wrapped around the body when the animal sleeps. There is no tail. There are four genera, with five species, distributed widely throughout the Old World tropics.

Megalaima (barbets; family Capitonidae) Genus of bulky, large-headed, large-billed, mainly green birds which have blue, yellow, and red head patterns. They inhabit forest, feed on fruit, and nest in tree holes. There are 23–5 species, found in Asia.

Megaloceras giganteus *See* allometry; and Cervidae.

Megalomycteridae (large-nose fish; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Small family of deep-sea fish with an elongate body, the spineless dorsal and anal fins located near the tail-fin, and an unusually large olfactory organ ('large nose'). There are five species, with worldwide distribution.

Megalonychoidea (ground sloths; order Edentata, suborder Xenarthra, infra-order Pilosa) Extinct superfamily of ground-dwelling edentates which are known first from the Oligocene, but which thrived during the Pleistocene in N., C., and S. America, and which may be broadly ancestral to modern tree sloths. Early forms attained a length of little more than a metre; but later much larger forms appeared, including *Megatherium*, which was more than 6 m long, and more massive than an elephant. Ground sloths had claws on all five digits on each limb, the claws in some species being so large as to require the animal to walk with its feet turned on their sides, as do modern New World ant-eaters. The teeth were reduced and simple and some may have possessed horny plates used in cropping vegetation. Later ground sloths were contemporaries of early man: a skeleton of *Nothrotherium* (an animal about the size of a tapir) has been found that shows signs of having been killed by humans. In the W. Indies ground sloths evolved into dwarf forms, some no larger than a cat.

Megalopidae (tarpon; class Osteichthyes, subclass Actinopterygii, order Elopiformes) Small family of essentially marine fish with a streamlined body and silvery scales. The mouth is in a slightly oblique position with the lower jaw protruding. All the fins are soft-rayed. The dorsal fin is located midway along the back, and the last ray is extended into a long, filamentous tip. The forked tail-fin is indicative of a strong swimmer. Although not rated highly as a food fish, the large (up to 2 m) *Tarpon atlanticus* (tarpon) is popular with game fishermen because it fights when hooked. There are only two species, found in both tropical and subtropical oceans.

megalops *See* postlarva.

Megaloptera (alderflies; class Insecta, subclass Pterygota) Order of mandibulate endopterygotes, which have two dissimilar pairs of wings and whose larvae are aquatic. The larvae have well-developed mandibulate mouthparts, functional legs, and lateral, abdominal gills. The pupae are adecticous and exarate, pupation taking place in a silken cocoon spun from the larval anus. The predacious larvae are an important part of the diet of freshwater fish, and are often used for bait. Many adults are large, *Corydalus* (American Dobson fly) having a wingspan of 16 cm. This small order comprises some 300 described species, most of which occur throughout the temperate regions, although a few occur in the tropics.

Megalosaurus pannoniensis One of the last species of *Megalosaurus*, a genus which existed for a very long time. Found in the Upper Cretaceous of Portugal, *M. pannoniensis* is just one species within a rather heterogeneous assemblage of large carnivorous dinosaurs referred to the family Megalosauridae.

meganephrostomal In the nephridia of Oligochaeta, applied when the nephridial funnel is well developed and when its upper lip is shaped like a horseshoe.

Meganeura (giant dragonfly; order Odonata, suborder Meganisoptera, family Meganeuridae) Genus of gigantic fossil dragonfly-like insects from the Upper Carboniferous, that had no nodus, pterostigma, or quadrilateral triangle, and so lacked the well-known venational characteristics of present-day Odonata. They were probably the largest insects ever to have lived. *M. gracilipes* had a wing-span of 70 cm. *M. monyi* had a wing-span of 60–70 cm.

Meganisoptera (Paralogidae, dragonflies; order Odonata) Extinct suborder of large, Palaeozoic

dragonflies that show no nodus or pterostigma on the wing. The suborder includes some of the largest insects known. Some fossils have wing-spans of 65 cm or more.

Megapodagrionidae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies which breed in bog-holes and streams. Some species show anatomical modifications for displaying bright coloration. They are distinguished from other damselflies by having a well-developed, separate, first anal wing vein, and many supplementary veins on the distal wing margins. The larvae are short and stout, with broadly foliate, caudal gills. The family occurs in the tropics. More than 180 extant species have been described.

megapodes *See* Megapodiidae.

Megapodiidae (megapodes; order Galliformes) Family of mainly brown or black, turkey-like birds, many of which have bare heads, although one species is crested. They have small to large bills; large, rounded wings; and very large, strong feet. They inhabit forests and scrub, and feed on insects, worms, seeds, and fruit. Their eggs are incubated in mounds of earth and vegetation, warmed by the Sun and by fermentation. There are seven genera, comprising 12 species, found in the Philippines, Indonesia, Australasia, and Polynesia.

Megapodius (scrubfowl; family Megapodiidae) Genus of brown and grey megapodes including *M. freycinet* (scrubfowl), which has a short crest, and yellow legs. There are three species, found in Australasia, Indonesia, and Polynesia.

Megaptera novaengliae (humpback whale) *See* Balaenopteridae.

megaripple *See* dune bedform.

megasporangium Spore sac that contains megaspores. In flowering plants this is known as the ovule. *See also* heterospory; and microsporangium.

megaspore The larger of two kinds of spore produced by heterosporous ferns, or the first cell of the female gametophyte generation of such ferns and seed plants (angiosperms and gymnosperms). In angiosperms it is one of four haploid cells formed from a megasporocyte during meiosis, the other three degenerating. The megaspore of angiosperms divides to produce the female gametophyte or embryo sac.

megasporocyte Diploid megaspore mother cell in an ovule that forms haploid megaspores by meiotic division.

megatherm In Alphonse de Candolle's (1874) classic temperature-based scheme of world vegetation zones, a plant of the most warm (i.e. tropical) environments, where moisture supply is not limited. *Compare* xerophile.

megathermal climate High-temperature climate type, known more commonly in Europe (e.g. in the Köppen classification) as humid subtropical or tropical, with a coldest monthly mean temperature above 18 °C. The term is also defined in the Thornthwaite classification by potential evapotranspiration and moisture-budget criteria. *See also* Köppen climate classification; and Thornthwaite climate classification.

Meinertellidae (subclass Apterygota, order Archaeognatha) One of the two present-day archaeognathan families, whose members are distinguished from the Machilidae by the possession of very small abdominal sternites which protrude slightly between the coxal plates. The legs and scape, and the pedicel of the antennae, are not covered with scales. Principally a southern-hemisphere taxon, members of the family are found on coastal cliffs, in forests, and in rain forests.

meiosis (reduction division) A mechanism whereby: (a) each gamete only receives one member of a chromosome pair, so that the diploid number ($2n$) of the original cell is reduced to a haploid number (n) of the four products—this forms one of the bases of Mendel's first law of genetic segregation; (b) genetic material can be exchanged between homologous chromosomes. Two successive divisions of the nucleus occur, with corresponding cell divisions, following a single chromosomal duplication. This produces gametes (in animals) or sexual spores (in plants) that have one half of the genetic material or chromosome number of the original cell. This halving of the chromosome number ($2n$ to n) compensates for its doubling when the gametes ($n + n$) unite to form a zygote ($2n$) during sexual reproduction. The process occurs during gamete formation in animals or during spore formation in plants; in many fungi, green algae, and in sporozoa, it occurs immediately after fertilization or on germination of the zygote. Chromosomes first appear in the first stage (leptotene) of meiosis, as single threads. The two homologous members of each chromosome pair associate side by side with corresponding loci adhering together: this is called pairing. It occurs during zygotene stage, each resulting pair being called a bivalent. Thus the *apparent* number of chromosome threads is half what it was before, being the number of bivalents rather than the number of single chromosomes. During the pachytene stage, each bivalent separates into two sister chromatids (except at the region of the centromere), with some localized breakage and crossing over of genetic material of both maternal and paternal origin. There are now n groups of four chromatids lying parallel to each other and forming a tetrad. During the diplotene stage, one pair of sister chromatids in each of the tetrads begins to separate from the other pair except at the sites where exchanges have taken place. In these regions the overlapping chromatids form a cross-shaped structure called a chiasma (pl. chiasmata) and these chiasmata slip towards the ends of the chromatids so that their position no longer coincides with that of the original cross-overs. This process continues until, during diakinesis, all the chiasmata reach the ends of the tetrads and the homologues can separate during anaphase. At diakinesis the chromosomes coil tightly, so shortening and thickening to form a group of compact tetrads which are well spaced out in the nucleus, and the nucleolus disappears. This ends the prophase stage of meiosis. During the first division (metaphase through to telophase), the nuclear envelope disappears, with the tetrads

arranged at the equator of the spindle. The chromatids of a tetrad separate in such a way that maternal chromosomal material is kept distinct from paternal material except at regions distal to the points of crossing-over. This first division produces two secondary gametocytes containing dyads (a dyad is half a tetrad) each of which becomes surrounded by a nuclear envelope. After a short interphase, the second division begins. The nuclear membrane disappears once more and the dyads arrange themselves upon the metaphase plate, the chromatids of each dyad being equivalent to one another (except for those regions distal to points of crossing over). The centromere divides and so allows each chromosome to pass to a separate cell and the process is complete. *Compare* mitosis.

meiotic drive Any meiotic mechanism that results in the unequal recovery of the two types of gamete produced by a heterozygote.

Melaleuca (family Myrtaceae) Genus of woody shrubs or small trees, with opposite, entire leaves. The flowers are regular, bisexual, cymose or solitary, with four or five sepals and a similar number of petals. There are numerous stamens in tufts opposite the petals. The ovary is inferior, with several locules and a long simple style. The fruit is a fleshy berry or dry capsule, and the seeds have little endosperm. The plants exhibit xerophytic characters, e.g. thickened leaves and sub-epidermal oil glands. Many are halophytic (salt-tolerant) but they are typically present in tropical areas that experience heavy summer rainfall, and occur in many *Eucalyptus* forests in areas of low fertility. Some species are important for aromatic oils, e.g. *M. leucadendron* gives cajeput oil. There are 141 species, of which all but one occur native only in Australia, although they are cultivated elsewhere for their flowers. *Melaleuca* and the related *Callistemon* are commonly known as 'bottlebrushes'.

Melamphaeidae (Melampheidae; bighead, bigscale; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of deep-sea fish with a relatively large head supported by thin bones, a large mouth, and small eyes. The body, not deeper than the head, is covered by thin and large scales. The pectorals are as long as the single dorsal fin and much larger than the pelvic fins. Melamphaeidae are commonly found at depths of around 1000 m. There are about 20 species, distributed worldwide.

Melampsoraceae (order Uredinales) Family of rust fungi, in which the teliospores are sessile and unicellular, often forming a crust-like layer beneath the epidermis of the host plant. The aecia are not cup-shaped but are diffuse. There are many genera. The family includes some important plant pathogens.

Melanconiaceae (order Melanconiales) Family of imperfect fungi with the characteristics of the order. There are many genera, including some that can cause disease in plants.

Melanconiales (class Coelomycetes) Order of imperfect microscopic fungi which produce conidia within acervuli. There is one family, which includes saprotrophic and parasitic fungi found on plant material.

Melanerpes (woodpeckers; family Picidae) Genus of mainly black and white woodpeckers, most of which have red crowns and white rumps, and white or black, barred, central tail feathers. The bill is long, and they have four toes. They inhabit semi-open country and forests, feed on insects, and nest in holes in trees and cacti. There are 21 species, found in N., C., and S. America.

Melanesia and Micronesia floral region Part of Good's (1974) Polynesian subkingdom, within his Palaeotropical kingdom, and geographically coinciding with Micronesia (Marianas, Carolines, Marshalls, Kiribati, and Tuvalu) and Melanesia (New Guinea, Solomon Islands, Vanuatu, and Fiji, but not New Caledonia). Although there is an appreciable endemic component at the species level, most of the species belong to large, widespread genera. The status of the endemism is not high, therefore, and reflects the fact that the flora is largely derived from adjacent floras.

melanin Group of dark pigments found in the skin and formed in melanoblast cells through the oxidation of tyrosine, phenylalanine, and other aromatic compounds.

melanism In an animal population, the occurrence of individuals that are black owing to the presence in excess of the pigment melanin.

Melanitta (scoters; family Anatidae) Genus of mainly marine ducks, the males of which are black, the females brown. They have large bills, brightly coloured in *M. perspicillata* (surf scoter). In winter they occur in coastal regions. They breed inland near isolated lakes and pools in open and wooded areas, and nest upon the ground. They feed on molluscs obtained by diving. There are three species, found in the northern regions of N. America, Europe, and Asia.

Melanitta perspicillata (surf scoter) *See Melanitta*.

Melanocetidae (class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Small family of deep-sea anglerfish with a very large head and short body. The jaws of the huge mouth bear many sharp teeth. As in other anglerfish, the first dorsal spine forms a type of lure (illicium) located between the eyes. Species such as *Melanocetus murrayi* (11 cm) are found at depths of 50–2000 m. There are about nine species found in all major oceans.

Melanogrammus aeglefinus (haddock) *See* Gadidae.

Melanorrhea (family Anacardiaceae) Genus of medium-sized, evergreen trees in which the leaves are simple, and often crowded. The fruit is a small nut seated in enlarged, wing-like sepals. The black bark resin is highly irritant and provides lacquer. There are 20 species, occurring from S. China to W. Malesia.

Melanosporaceae (order Sphaeriales) Family of fungi in which simple perithecia are formed. The club-shaped asci are evanescent, their walls disintegrating within the perithecium. The ascospores

are black. There are many genera, most of which are saprotrophic in soil, on plant debris, etc.

Melanostigma pammelas (Pacific softpout) *See* Zoarcidae.

Melanostomiatidae (black dragonfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Fairly large family of deep-sea fish which have slender bodies, with a small head and small eyes, but a wide mouth. Both the dorsal and anal fins are located very close to the small tail-fin. The fish are scaleless, but bear rows of small light organs along the sides of the body. Many species possess a chin barbel. There are at least 90 species, found in all oceans.

Melanotaeniidae (rainbowfish; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Family of mainly freshwater fish with a deep, compressed body (especially in the males), a pointed snout, and a small mouth. The base of the anal fin is longer than that of the second dorsal fin. Being fairly easy to maintain and breed in captivity, rainbowfish are increasingly accepted as suitable aquarium fish, especially as some species—e.g. *Nematocentris australis* (W. Australian rainbowfish), which grows to 9 cm, and *N. fluviatilis* (crimson-spotted rainbowfish) of E. Australia, which grows to 9 cm—show striking colour patterns during breeding. There are about 19 species, found in tropical to subtropical waters around E. Indonesia and Australia.

Melastoma (family Melastomataceae) Genus of shrubs in which the leaves have three main nerves. The flowers are showy, mauve, pentamerous, with five big and five small stamens. The fruits are fleshy capsules. *M. malabathricum*, a weedy shrub, is the Straits rhododendron. There are 70 species, occurring from S. China to the Pacific islands.

Melastomataceae Family of small trees and shrubs, with a few climbers, herbs, and epiphytes in which the leaves are opposite, without stipules, and mostly with several main nerves. The flowers are hermaphrodite, and have four or five free sepals and petals, geniculate stamens with a prominent appendage, porous anthers, and usually an inferior ovary. The fruit is a berry or capsule. There are 240 genera, with 3000 species, found mainly in the tropics and subtropics, but with a few in warm-temperate regions.

Meleagrididae (turkeys; order Galliformes) Family of very large game birds, which are dark with a green and bronze sheen, and a bare, blue or red head with wattles. The wings are barred with white, the tail broad and rounded, the legs long and spurred. Turkeys are gregarious and terrestrial, and are found in wooded country. They feed on vegetable matter, and breed on the ground. There are two genera, with two species, found in N. and C. America.

Meleagris (turkey; family Meleagrididae) Monotypic genus, *M. gallopus* is the wild ancestor of the domestic turkey, with characteristic bare, red head wattles, and a 'gobbling' call. It inhabits woods in N. and C. America.

Meles (badger) *See* Mustelidae.

Melia (family Meliaceae) Genus of trees or treelets which have bipinnate or tripinnate leaves. The flowers are hermaphrodite; the fruit is a drupe. Some species have useful timber (*M. azendarach* (pride of India), native to the Himalayas but now naturalized throughout the tropics and subtropics). There are five species, found in the Old World tropics.

Meliaceae Family of trees and treelets most of which have spirally pinnate leaves. The flowers are bisexual or unisexual, and regular, with the sepals and petals united at the base, the stamens usually forming a tube, and the ovary superior, with 2–6 locules. Meliaceae produce a variety of fruits. Many are valuable timber trees. There are 51 genera, with about 500 species, occurring in the tropics and subtropics of both hemispheres.

Meliphagidae (honeyeaters; order Passeriformes) Family of small- to medium-sized, mainly green or grey-brown birds, some of which have patches of red, yellow, or white. Many have bare, wattled skin on the head, the bill is slender and curved, and the tongue has a brush-like tip. The wings are long and pointed, the tail is medium to long, and the legs are strong. Honeyeaters inhabit mainly forests; feed on nectar, insects, and fruit; and build a domed, open, or cup-like pendent nest in trees. There are 37 genera, with about 170 species, found in S. Africa and Australasia.

Melipona (stingless bees) *See* Apidae; hive; and honeybee.

melissopalynology The study of pollen grains in honey. This gives useful information regarding the flowers bees have visited, and may also be used to monitor the quality of honey—for example, the pollen content can be checked against the source claimed by vendors when the honey is marketed.

Melitta *See* Melittidae.

Melittidae (order Hymenoptera, suborder Apocrita) Family of short-tongued mining bees, in which the tongue lacks a flabellum; the mentum narrows basally and loops over the V-shaped lorum. Melittids superficially resemble the Andrenidae, but differ from members of that family in that they lack subantennal plates and have the scopa restricted to the posterior tibia and basitarsis. The family includes the genera *Dasypoda* (Old World), *Hesperapsi* (New World), *Macropis*, and *Melitta*. Females of *Macropis* collect plant oils as well as nectar.

melliferous Producing honey.

Mellisuga helenae (bee hummingbird) *See* Trochilidae.

Mellivora capensis (honey badger, ratel) *See* Mustelidae.

Meloidae (oil beetles, blister beetles; class Insecta, order Coleoptera) Family of beetles, of which the ground-living species (e.g. *Meloe proscarabaeus*, up to 32 mm long) have a large, swollen abdomen, reduced elytra, and no wings. Others occur on flowers, are parallel-sided, have normal elytra, have

warning coloration, and are fully winged. Meloidae contain cantharidin, a toxin producing skin blisters. Powdered elytra of *Lytta vesicatoria* (Spanish fly) is used in minute quantities as a supposed aphrodisiac. Larvae are minute and louse-like, with strong claws, and are insect parasites. Some attach to a bee host at a flower and are transported back to the nest, where they feed on host eggs and food stores. There are 2000 species.

Melolontha melolontha (cockchafer, Maybug) *See* Scarabaeidae.

melon (*Cucumis melo*) *See* Cucurbitaceae.

Melopsittacus (budgerigar; family Psittacidae) Monotypic genus comprising *M. undulatus*. This is a small, green, long-tailed parrot which has a black and white, barred head, and a small bill. It inhabits wooded grassland and open plains, feeds on seeds, and nests in holes in trees and stumps. It is known universally as a cage bird, and is bred in a variety of colour forms. Budgerigars are gregarious, forming large flocks, and, except for cage birds and their feral descendants, are confined to Australia.

meltemi *See* etesian winds.

meltout till *See* till.

meltwater channel Valley cut by the action of meltwater escaping from a decaying glacier. Various types may be recognized, classified by the position of the channel with reference to the glacier, e.g. marginal or subglacial. Usually these channels are unrelated to the present drainage pattern.

Membracidae (tree hoppers, thorn bugs; order Hemiptera, suborder Homoptera) Family of bugs in which the pronotum is produced backwards into a spine; it is often also produced laterally, and may be elaborated into fantastic shapes. Some species live as small 'families', each comprising a mother and her offspring, and these are usually attended by ants. There are about 2500 species, occurring mainly in the warmer regions of the world.

membrane Sheet-like structure, 7–10 nm wide, that forms the boundary between a cell and its environment and also between various compartments within the cell. It is composed mainly of lipids, proteins, and some carbohydrates, the structural arrangement of which is still subject to speculation. Membranes function as selective barriers and also as a structural base for enzymes, which may form an integral part of the membrane itself.

Memecylon (family Melastomataceae) Genus of small trees, which have exceedingly hard wood and very thin bark. The leaves have a single main nerve and innumerable close, faint, secondary nerves. The fruit is a berry. There are 150 species, occurring in the Old World tropics.

Mendelian character Character that follows the laws of inheritance formulated by Gregor Mendel.

Mendelian population Interbreeding group of organisms that share a common gene pool.

Mendel's laws Two general laws of inheritance formulated by the Austrian monk Gregor Johann Mendel (1822–84). The first law, of segregation, is that the two members of a gene pair segregate from each other during meiosis, each gamete having an equal probability of obtaining either member of the gene pair. The second law, of independent assortment, is that different segregating gene pairs behave independently. This second law is not universal as was originally thought, but applies only to unlinked or distantly linked pairs. At the time of Mendel, genes had not been identified as the units of inheritance: he considered factors of a pair of characters segregating and members of different pairs of factors assorting independently.

mendip Hill or ridge that has been buried by younger rocks and subsequently exposed by erosion. The type example is provided by the Mendip Hills, England, described by W. M. Davis in 1912.

Mene maculata (moonfish) *See* Menidae.

mengkulang (tlerihera) The timber of *Heritiera* from W. Malesia. It makes an attractive veneer for plywood.

menhaden (*Brevoortia tyrannus*) *See* Clupeidae.

Menidae (moonfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine fish which have an unusual body profile. The very deep body almost resembles a flat disc because of the strongly curved ventral contour, a very narrow tail ending in a forked tail-fin. Both dorsal and anal fins are long and low; the first ray of the pelvic fin is rather prolonged. ***Mene maculata*** (moonfish), 20 cm, is found in the warm coastal waters of the Indo-Pacific region.

meningitis Inflammation of the meninges (membranes that cover the brain and spinal cord). It may be caused by any of a variety of bacteria or viruses.

meningococcus *Neisseria meningitidis*, one of several possible causal agents of meningitis.

Menippe mercenaria (stone crab) *See* Xanthidae.

Meniscotheriidae (superorder Protoungulata, order Condylarthra) Extinct family of archaic ungulates, which were distributed throughout N. America and Europe during the Palaeocene and early Eocene, being common locally. *Meniscotherium*, typical of the family, was an animal about the size of a rabbit. It had molars of a selenodont pattern, rather similar to those of later artiodactyls. Its limbs were short and stout and appear to have ended in claws rather than hoofs.

Menispermaceae Family of lianes or shrubs, which have alternate or peltate leaves with no stipules, and unisexual, small, white or green flowers. The plants are dioecious. The flowers have two or three petals, and often two rows of three sepals. The stamens and carpels can be very numerous; the stigma is entire or lobed. The fruit is a drupe, often in a horseshoe shape. There are eight tribes, separated on seed structure; and 65 genera, with 350 species, which are mainly confined to tropical rain forests throughout the world. Several species are useful in medicine and the preparation of drugs.

Menoponidae (order Phthiraptera, suborder Amblycera) Family of chewing lice which are parasitic on birds of many orders. One genus, *Piagetiella*, lives inside the gular pouch of pelicans and cormorants, adult females passing through the nasal holes to lay eggs on the feathers. Another genus, *Actornithophilus*, contains species that live inside the quills of wing feathers, feeding on the quill material. Most species of Menoponidae, however, live among the feathers of the host. It is the largest family in the suborder, and includes about 650 species in 50 genera.

Mentha (mint; family Labiatae) Genus of herbs with creeping rhizomes, and flowers that have a 10–13-nerved calyx, with five nearly equal teeth, a corolla with four nearly equal lobes, and four equal stamens. The plant contains pleasantly fragrant volatile oils, much used in flavouring and for sauces. The oil is extracted and used also as a mild antiseptic. There are 25 species and many hybrids, occurring in temperate Eurasia and in S. Africa.

menthol *See* Labiatae.

Menura (lyrebirds) *See* Menuridae.

Menuridae (lyrebirds; order Passeriformes) Family of large, brown birds which have spectacular long tail feathers, most of them fine and filamentous, with two long central feathers, and two curved outer feathers in *Menura novaehollandia* (superb lyrebird). They inhabit forest and scrub, feed on small invertebrates, and build a large, domed nest on the ground. There are two species, confined to E. Australia.

Menyanthaceae (bogbean) Family of aquatic or wetland (bog) herbs, with creeping rhizomes or tufted rootstocks. They are mainly perennial. They are related to Gentianaceae, but are found in different habitats and have leaves that are mostly alternate. The regular flowers are borne in cymes or dense clusters. The corolla is five-lobed, with valvate lobes when in bud. The sepals (which remain in the fruit) and the united petals are pink, yellow, or white with a fringe of hairs in the flower. The stamens are attached to the corolla tube. The ovary is superior, with one locule and several ovules; the style is simple and forked. The fruit is a fleshy nut or dry capsule which is often dehiscent. The seeds contain much endosperm and are often winged. *Menyanthes* (buckbean) has trifoliate leaves; *Nymphoides* (fringed waterlily) has simple, round, waterlily-like leaves. There are five genera, with some 35 species, widespread in the world, although two of the genera are restricted to the northern hemisphere and two to the southern hemisphere. Some species are garden ornamentals, and species of *Menyanthes* are used in medicine.

Menyanthes (buckbean) *See* Menyanthaceae.

meranti *See Shorea*.

merawan Hard, heavy timber of some *Hopea* species from W. Malesia, which is good for construction.

merbau Timber of *Intsia* from the Malay archipelago, which is dark, heavy, and good for furniture and flooring.

Merceya *See* copper mosses.

meremium Timber obtained from standing trees.

mergansers *See Mergus*.

Mergus (mergansers, sawbills; family Anatidae) Genus of medium-sized to large ducks which have long, narrow, serrated bills. Males are usually patterned black and white; females are duller, with chestnut heads. They inhabit rivers, estuaries, and the sea; feed on fish caught by diving; and nest in tree holes. There are six living species (*M. australis*, Auckland Island merganser, is extinct) found in N. Europe, Asia, and N. and S. America.

Mergus australis (Auckland Island merganser) *See Mergus*.

meridional circulation Air circulation in a cell or general flow to or from different latitudes, usually with a marked south to north or north to south component. *See also* Hadley cell; and zonal flow.

Meripilus (family Polyporaceae) Genus of fungi which form large, fan-shaped fruit bodies in rosette-like clusters. The upper surface is marked with concentric zones of light and dark brown; the pores on the lower surface are small. There are two species, including *M. giganteus* ('giant polypore'). They are found at the bases of living or dead, broad-leaved trees.

meristem Group of plant cells that are capable of dividing indefinitely, and whose main function is the production of new growth. They are found at the growing tip of a root or stem (apical meristem); in the cambium (lateral meristem); and, in grasses, also within the stem and leaf sheaths (intercalary meristem).

Merlucciidae (hake; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Small family of marine fish which have a rather elongate body shape, a large head, and mouth with well-developed teeth. The first dorsal fin is short and triangular, the second dorsal and anal fins are long and may show a notch near the middle. Several species, including the European *Merluccius merluccius* (hake), 1 m, are important food fish. Often found at depths of more than 200 m, the large schools of hake may come closer inshore during summer. There are about 13 species, with worldwide distribution.

Merluccius merluccius (European hake) *See* demersal fish; and Merlucciidae.

mermaid *See* Sirenia.

mermaid's cup (mermaid's wineglass) Common name for the stalked, wineglass-shaped thallus of the green alga *Acetabularia*.

merocenosis *See* merotope.

merocrine glands Glands whose secretions contain little or no solid material contributed by the disintegration of cells of the gland itself. *Compare* apocrine gland.

merogamete In Protozoa, a gamete formed by multiple division of the parent and so smaller than the parent. Where male and female gametes are strongly differentiated, merogametes are male and hologametes female.

Meroglossa *See* Colletidae.

merological approach An approach to ecosystem studies in which the component parts of an ecosystem are studied in detail in an attempt to compose a picture of the whole system. *Compare* holistic.

meromictic Applied to lakes whose waters are stratified permanently, usually because of some chemical difference—e.g. contrasting salinities, and hence densities—between epilimnion and hypolimnion waters.

Meropidae (bee-eaters; order Coraciiformes) Family of small- to medium-sized, brightly coloured birds which have long, slender, decurved bills; long, pointed wings; and syndactylous feet. Many have elongated central tail feathers; some have long throat feathers. They inhabit forest and open country, feed on insects, particularly bees and wasps, and nest colonially in burrows in a bank. There are three genera, with 24 species, many migratory, found in Europe, Africa, Asia, and Australasia.

meroplankton Temporary zooplankton, the larval stages of other organisms. *Compare* holoplankton.

Merops (bee-eaters; family Meropidae) Genus of bright green, blue, yellow, and red bee-eaters, some of which have square or forked tails. *M. apiaster* (bee-eater) is the only species that breeds in Europe. There are 21 species, found in Europe, Africa, Asia, and Australasia.

Merops apiaster (bee-eater) *See Merops*.

Merostomata (phylum Arthropoda) Class which includes the king crabs (horseshoe crabs) and the extinct eurypterids. The eurypterids or 'water scorpions', which grew up to 3 m long, ranged from the Ordovician to the end of the Palaeozoic; the king crabs also appeared in the Lower Palaeozoic and have survived to the present.

merotope Microhabitat forming part of a larger unit, e.g. a fruit or a pebble. Organisms colonizing the merotope form a merocenosis.

Merremia (family Convolvulaceae) Genus of large tropical creepers, several of which have stout stems. Several are noxious weeds of disturbed forest. There are 80 species.

mersawa *See Anisoptera*.

Merycoidodontidae Relatively small, extinct group of artiodactyls, which appeared in the Eocene, expanded in the Oligocene, and thereafter dwindled to extinction in the Pliocene.

mesa Flat-topped hill of limited extent, but wider than a butte and normally underlain by nearly horizontal sedimentary material. A structure similar to a mesa but larger is called a 'plateau'.

Mesaxonia (infraclass Eutheria, cohort Ferungulata) Superorder comprising those extant and extinct ungulates in which the third digit bears most of the weight of the animal, the other digits being reduced. The name means 'middle axis'. The superorder includes the one order Perissodactyla.

mesaxonic Applied to vertebrate limbs in which the weight of the animal passes through the third digit.

mescal *See Agave*.

mesentery 1 In Actinozoa, vertical partitions in the coelenteron (single body cavity). 2 In vertebrates, folds in the dorsal portion of the membrane lining the abdominal cavity (peritoneum) in which the abdominal organs are supported, so that these organs are slung from the wall rather than lying in the cavity proper. The folds supporting the stomach, liver, duodenum, and spleen are termed omenta (sing. omentum); those supporting the remainder of the intestine are mesenteries.

mesepimeron *See* mesepisternum.

mesepisternum Pleural sclerite on the mesothorax of an insect, which is thought to be derived from the subcoxal elements of the ancestral legs, and dissected by a suture from the other pleural sclerite, the mesepimeron.

mesic Applied to an environment that is neither extremely wet (hydric) nor extremely dry (xeric). *See also* pergelic.

mesites *See* Mesitornithidae.

Mesitornithidae (mesites; order Gruiformes) Family of medium-sized birds which are mainly brown above, and plain, spotted, or barred below. They have long tails, short wings, and medium-length, straight or decurved bills. They have a well-developed hallux, and are mainly terrestrial, rarely flying. They inhabit forests and scrub; feed on insects, fruit, and seeds; and nest in bushes and low trees. There are two genera, with three species, confined to Madagascar.

meso- Prefix meaning middle, e.g. 'mesotrophic', neither nutrient-poor nor nutrient-rich; and 'mesobiota', the medium-sized soil organisms.

mesobiota (mesofauna, mesoflora) General term for soil organisms of intermediate size. 'Mesofauna' in particular refers to small, invertebrate animals found in the soil, characteristically annelids, arthropods, nematodes, and molluscs. These organisms are readily removed from a soil sample using a tullgren funnel or similar device. *Compare* macrobiota; and microbiota.

mesocarp *See* pericarp.

mesoclimate General term applied to the characteristics of a relatively small region, e.g. a valley or urban area.

Mesocricetus auratus (golden hamster) *See* Cricetidae.

mesoderm In an animal embryo, the layer of cells that gives rise to muscle, blood vessels, and the organs of the body.

mesofauna *See* mesobiota.

mesoflora *See* mesobiota.

Mesogastropoda (phylum Mollusca, class Gastropoda) Order of prosobranch gastropods in which individuals possess one pectinibranch gill and one kidney. The shell is generally helicoid, the aperture

being entire. The morphology of the radula is variable, and the sexes are separate. This large order contains terrestrial, marine, and freshwater forms, and first appeared in the Lower Ordovician.

mesogloea In Coelenterata and Porifera, a layer between the external and internal layers of the body wall.

mesohaline *See* brackish.

mesonephrostomal In the nephridia of Oligochaeta, applied when the upper lip of the nephridial funnel consists of only a few cells.

mesonotum The dorsal, sclerotized cuticle of the second thoracic segment of an insect. *See also* mesothorax.

Mesonychidae (superorder Protoungulata, order Condylarthra) Extinct family of condylarths, formerly classified as creodonts, which are believed to show that modern ungulates and carnivores are descended from a common stock. They appeared first in the Palaeocene, became more common in the Eocene, and had disappeared by the middle of the Oligocene. They had upper cheek teeth that were triangular, each with three blunt cusps and lower molars apparently adapted for shearing. The feet were probably hoofed. Some later forms were large. *Mesonyx* was about 1.5 m long, but judging by the comparative sizes of their skulls *Andrewsarchus*, which lived in Mongolia, may have attained a length of 4.5 m. The animals may have fed on tough vegetable material or carrion.

mesopause In the atmosphere, the inversion at about 80 km height, which separates the mesosphere from the thermosphere above, in which the first 10 km are almost isothermal. The mesopause is liable to be marked by noctilucent cloud composed of ice crystals on meteoric dust. *See also* atmospheric structure.

mesophile Organism that grows best at moderate temperatures, often quoted as 20–45 °C.

mesophyte Plant adapted to environments that are neither extremely wet nor extremely dry. *Compare* hydrophyte; and xerophyte.

mesopleurum Lateral, sclerotized cuticle of the second thoracic segment of an insect. *See also* mesothorax.

Mesosauria Order of anapsid reptiles, with just one family, the Mesosauridae. The mesosaurs are known only from late Carboniferous or early Permian rocks in S. America and S. Africa. They were adapted to life in fresh water, lightly built, and up to one metre in length.

mesosoma 1 *See* Enteropneusta. 2 In Hymenoptera, the combined thorax and first abdominal segment. *See also* gaster; metasoma; and Scorpiones.

mesosome Complex infolding of the plasma membrane in prokaryotic cells. It contains respiratory enzymes and also appears to play a role in cell division, since the chromosome is usually attached to it and it is often the site of initiation of cytokinesis.

mesosphere Upper-atmospheric layer above the stratopause (at 50 km) through which temperature decreases with height up to about 80 km, where temperatures reach a minimum of about −90 °C. This level is the mesopause, an inversion above which temperatures rise again. *See also* atmospheric structure.

mesosternum Ventral, sclerotized cuticle of the second thoracic segment of an insect. *See also* mesothorax.

mesostracum Shell layer, composed of calcium carbonate, that occurs in some of the more advanced polyplacophorans. It is situated between the middle and outer layers of the shell.

mesotherm Plant of warm-temperate areas according to Alphonse de Candolle's (1874) classic temperature-based scheme of world vegetation zones.

mesothermal climate Climatic type with moderate temperatures, known most commonly in Europe, e.g. in the Köppen classification, as a warm-temperate rainy climate having a coldest month with temperatures of −3 °C to +18 °C and a warmest month above +10 °C. Such climates are found typically in latitudes 30–45°. The Thornthwaite classification defines this type according to evapotranspiration and moisture budget. *See also* Köppen climate classification; and Thornthwaite climate classification.

mesothorax The second thoracic segment of the body of an insect, consisting of a cuticular box made up of a mesonotum dorsally, mesopleura laterally, and a mesosternum ventrally. The mesothorax bears a pair of legs, and in addition may carry a pair of wings.

mesotidal Applied to coastal areas where the tidal range is 2–4 m. Tidal action and wave activity both tend to be important in such areas.

Mesoxaea *See* Oxaeidae.

Mesozoa Phylum of small, marine, multicellular organisms which are simply ciliated and which adopt an endoparasitic mode of life within certain marine invertebrates.

Mesozoic The middle of three eras that constitute the Phanerozoic period of time. The Mesozoic (literally 'middle life') was preceded by the Palaeozoic Era and followed by the Cenozoic Era. It lasted 160 million years, beginning with the Triassic 225 million years ago and ending 65 million years ago at the start of the Tertiary. The Mesozoic comprises the Triassic, Jurassic, and Cretaceous Periods.

Mespilus (medlar; family Rosaceae) Monotypic genus of trees, close to *Malus* but with the carpels exposed in a disc within the wide ring of the persistent calyx at the top of the fruit, and with solitary flowers and large leaf-like sepals. Fruits can be eaten when they become soft and brown. They are native to Europe and SW Asia.

messenger-RNA Single-stranded RNA molecule responsible for the transmission to the ribosomes

of the genetic information contained in the nuclear DNA. It is synthesized during transcription and its base sequencing exactly matches that of one of the strands of the double-stranded DNA molecule.

Messinian Important stage of the Late Miocene, marked by the presence of thick evaporite deposits in the Mediterranean. These may indicate that the Straits of Gibraltar were closed approximately 6-7 million years ago and that the Mediterranean was reduced to a series of evaporite basins.

Messor (harvester ant; order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Myrmicinae) Genus of seed-eating ants which store grain in chambers within the soil nest. There are about 100 species: they occur in arid areas of the Old World.

Mesua (family Guttiferae) Genus of trees or shrubs in which the fruit is either dehiscent or not, and is seated on, or enveloped by, the enlarged woody sepals. The timber (notably ironwood from *M. ferrea*) is hard, heavy, and durable. There are about 50 species, occurring from Sri Lanka to Queensland.

metabolic pathway Sequential series of enzymatic reactions involving the synthesis, degradation, or transformation of a metabolite. Such a pathway may be linear, branched, or cyclic, and directly or indirectly reversible.

metacarpal In the forelimb of a tetrapod, one of the rod-like bones that articulate proximally with the carpus and distally with the phalanges. In humans, the metacarpals occupy the palm region of the hand.

metacentric Term applied to a chromosome that has its centromere in the middle.

metacone In primitive, triconodont, upper molar teeth whose cusps are in line, the posterior cusp. Where the cusps are not in line the metacone is the inside, posterior cusp.

metagenesis Alternative term for the alternation of generations among animals. It is commonly seen in invertebrates, particularly in coelenterates.

Metallogenium Genus of bacteria not assigned to any taxonomic family. Cells lack rigid walls and develop flexible, tapering threads from which new cells probably arise by budding. The threads are often heavily encrusted with oxides of iron and/or manganese. There are two species, found in a range of freshwater habitats and in soil.

Metameria Segmented organisms, including the annelids and arthropod phyla, which radiated from a flatworm ancestor about 700 million years ago.

metameric segmentation The repetition of organs and tissues at intervals along the body of an animal.

metamorphic rock Rock that has been transformed by metamorphism. The changes may be textural, chemical, or mineralogical.

metamorphism Changes of a rock due to the effects mainly of pressure and temperature, but also of fluids. Metamorphic changes take place in the solid phase. Limits are diagenetic-igneous processes.

metamorphosis Abrupt physical change. The word derives from the Greek *meta* (meaning 'change') and *morphe* ('form'). The term is used in a restricted sense for the transformation from the larval to the adult condition, as in the classes Insecta, Amphibia, etc.

metanauplius larva Later nauplius stages in Crustacea. *See also* nauplius larva.

metanotum Dorsal, sclerotized cuticle of the third thoracic segment of an insect. *See also* metathorax.

metaphase Stage of mitosis or meiosis at which the chromosomes move about within the spindle until they eventually arrange themselves in its equatorial region.

Metaphyta Kingdom that includes all the plants. The earliest true plants were probably unicellular green algae, which first appeared in the Precambrian. The bryophytes (mosses, liverworts, and hornworts) are known from the Devonian, and the first recorded vascular plants date from the Silurian.

metapinnule *See* Goniactinida.

metapodium In tetrapods, general term describing either the metacarpal or the metatarsal bones.

metapophysis In Edentata, the additional anterior articulating facet on the posterior vertebrae.

Metasequoia (family Taxodiaceae) Genus of one species, *M. glyptostroboides* (dawn redwood), a deciduous conifer known as fossils from America and in 1948 discovered living in China. It is planted as an ornamental, is fast-growing in wet sites, and strikes easily from cuttings.

metasoma 1 *See* Enteropneusta. 2 In Hymenoptera, those segments that lie behind the petiole (i.e. the abdomen from the second segment). *See also* gaster; mesosoma; and Scorpiones.

metasomatism Kind of metamorphism that involves the introduction of chemical constituents into a rock, or their removal from it (or both), via a volatile phase. Complete mineral transformations may occur, but the rock texture may remain (resulting in a 'pseudomorph').

metastasis The act of dispersal by cancer cells.

metasternum Ventral, sclerotized cuticle of the third thoracic segment of an insect. *See also* metathorax.

metatarsal In the hind limb of a tetrapod, one of the rod-like bones that articulate proximally with the tarsus and distally with the phalanges.

Metatheria (class Mammalia, subclass Theria) Infraclass comprising the single order Marsupialia, the modern marsupials and their extinct relatives.

metathorax Third thoracic segment of the body of an insect, consisting of a box of sclerotized cuticle. The metathorax bears a pair of legs, and in addition may carry a pair of wings.

Metazoa Animals, one of the three multicellular kingdoms, arose in the Precambrian Era, the sponges from one kind of protistan forebear, and

all other animals from another (or possibly more than one other) protistan. The oldest fossils are burrows of a coelomate, in rocks rather less than 700 million years old.

meteor Incandescent trail of a meteoroid entering the atmosphere. It is popularly referred to as a 'shooting star'.

meteorite Extraterrestrial body, probably originating in the asteroidal zone, that enters the Earth's atmosphere. An estimated 1500 land annually, with a total mass greater than 100 kg. Meteorites are classified into four groups according to their composition and structure.

meteoroid Small, solid body that enters the Earth's atmosphere from space.

Methanobacteriaceae Family of bacteria which have a specialized type of energy-yielding metabolism in which methane is an end-product. The organisms can grow only in the absence of air. They are found in anaerobic habitats, e.g. sewage sludge, the intestines of animals, sediments in natural waters, and waterlogged soils.

methanogenic Applied to bacteria that produce methane gas as a product of their metabolism.

methanotroph Bacterium that can use methane gas as a nutrient.

methionine Neutral, non-polar amino acid containing sulphur in a thio-ester linkage. It is an essential requirement in the diet of mammals.

methylation Introduction of a methyl group ($-CH_3$) into an organic compound.

Methylomonadaceae Family of Gram-negative bacteria which can use as nutrients only methane, methanol, or similar ('one-carbon') compounds. The cells may be motile or non-motile. They are chemo-organotrophic, and can grow only in the presence of air. There are two genera.

methylotroph Organism that can use (as the sole source of carbon and energy) organic compounds that contain only one carbon atom, i.e. compounds such as methane and methanol.

Metrosideros (family Myrtaceae) Genus of trees or shrubs. Some of them are stranglers; some of them have showy inflorescences from the numerous exserted stamens and are grown for ornament. There are 60 species, occurring in warm-temperate regions of the southern hemisphere.

Metroxylon (sago palms; family Palmae) Genus of big palms, most of which form a huge, tree-like, terminal inflorescence and die after fruiting. Some are clump-forming. The leaves are pinnate, and weakly spiny. They are monoecious. The flowers are held in spikes subtended by bracts, comprising a male, plus a female or hermaphrodite. The fruits are scaly. The endosperm is hard, a vegetable ivory. There are about eight species, occurring from the Moluccas east to the Carolines and Fiji.

Metroxylon sagu (sago palm) Clump-forming palm, native to the Moluccas and New Guinea, now extensively cultivated in Malaysia and the Solomon Islands for its leaves (which are used to make a superior thatch) and for the starch in its trunk (which is used as food for animals or for humans during famine, and which is still the staple in parts of its natural range in New Guinea). Formerly it was cultivated for its fruits, which yield a vegetable ivory.

Meuhlenbeckia *See* Polygonaceae.

Mexican bean beetle (*Epilachna varivestris*) *See* Coccinellidae.

Mexican burrowing toad (*Rhinophrynus dorsalis*) *See* Rhinophrynidae.

Mexican lilac (*Gliricidia sepium*) *See Gliricidia*.

Mexican lion (*Puma concolor*) *See Puma*.

mezcal *See Agave*.

Mg *See* magnesium.

Miacidae (order Carnivora, suborder Fissipedia, superfamily Miacoidea) Extinct mammalian family, known from the Palaeocene and Eocene, which is believed to be directly ancestral to the modern carnivores and which itself evolved directly from insectivore stock. Most Miacidae were small animals, typically much the size and shape of a modern weasel (with a long body and short legs), and were arboreal forest dwellers. They had larger brains than their creodont contemporaries and the carnassials were well developed, formed by the elongated fourth premolar and first molar, the cusps forming ridges.

Miacoidea (order Carnivora, suborder Fissipedia) Extinct superfamily of early carnivores, comprising the single family Miacidae and known from the Palaeocene and Eocene, during which it had a wide Holarctic distribution.

Michaelis constant Kinetic constant, K_m, characteristic of each enzyme, which is numerically equal to the concentration, in moles per litre, of the given substrate that gives half the maximal velocity.

michaelmas daisy *See Aster*.

Michelia (family Magnoliaceae) Genus of trees and shrubs in which the fruiting carpels are free, and laxly spaced. *M. figo* is cultivated for its perfume, used in China for hair oil and scented tea. There are 45 species, occurring in subtropical and tropical Asia.

Michelinoceratida (class Cephalopoda, subclass Nautiloidea) Order of mainly orthoconic cephalopods which are morphologically quite varied. The siphuncle is near the centre of the chamber, and connecting rings and septal necks are present. The order ranges in age from Lower Ordovician to the end of the Triassic.

Micrastur (forest falcons; family Falconidae) Genus of small to medium falcons which have short, rounded wings; short to long tails; short, deep bills; and long legs. They are grey or brown above, plain or barred below, with dark, white-barred tails, and a facial ruff of feathers. They inhabit dense forest, prey on birds, and nest in trees. There are five species, found in C. and S. America.

micro-aerobic Applied to an environment in which the concentration of oxygen is less than that in air.

micro-aerophilic Applied to an organism that grows best under micro-aerobic conditions.

microbe *See* micro-organism.

microbial (microbic) Of or pertaining to micro-organisms.

microbial genetics The study of the genetics of micro-organisms. This is an important discipline of genetics, since micro-organisms may be bred in captivity and since many generations can be obtained in short periods of time: their heredity can therefore be studied more readily than that of higher organisms.

microbic *See* microbial.

microbiocoenosis *See* biocoenosis.

microbiology The study of micro-organisms and allied subjects.

microbiota (microfauna, microflora) The smallest soil organisms, comprising bacteria, fungi, algae, and protozoa.

microbody Term sometimes used to denote peroxisomes and glyoxysomes.

Microcebus (mouse lemur) *See* Cheirogaleidae.

Microchiroptera (cohort Unguiculata, order Chiroptera) Suborder of bats, which orientate themselves and locate prey principally by means of echo-location, aided by large, specialized ears and in many species by modifications of the nose which serve to beam the sound emissions. Typically, microchiropterans are insectivorous, but many have adapted to diets of fruit, fish, flesh, nectar, or blood, and although the suborder has a worldwide distribution many families within it have a very restricted range. In some families implantation is delayed until the spring following autumn copulation. Gestation is from 50 days to eight months, and the young of some species do not fly until they are ten weeks old. Microchiropterans are known to have lived in the Palaeocene and today they are among the most successful of all mammal groups. There are about 18 families, with some 700 species in all.

microclimate The atmospheric characteristics prevailing within a small space, usually in the layer near the ground that is affected by the ground surface. Special influences include the impact of vegetation cover on humidity (by evapotranspiration) and on temperature and winds. *See also* urban climates.

Micrococcaceae Family of bacteria in which the cells are Gram-positive and spherical, and occur in regular or irregular groups. They may be motile or non-motile. Resting stages are unknown. They are chemo-organotrophic. There are several genera, found in a wide range of habitats—in soil, in aquatic environments, on the bodies of animals (including humans), etc.

microconsumer *See* consumer organism.

microcosm Late nineteenth-century American term encompassing essentially the same ideas as the ecosystem concept. Now it is applied especially to small-scale, simplified, experimental ecosystems, laboratory- or field-based, which may be either derived directly from nature (e.g. when samples of pond water are maintained subsequently by the input of artificial light and gas-exchange) or built up from axenic (organism-free) cultures until the required conditions of organisms and environment are achieved. Such small-scale experimental ecosystems may also be called 'micro-ecosystems'.

Microcyprini Older name for a group of fish including the Cypridontidae (toothcarps) and Poeciliidae (live-bearers).

Microcystis (order Chroococcales) Genus of cyanobacteria in which the small cells are densely packed in mucilage to form irregularly-shaped, often perforated colonies. They are found in aquatic environments—lakes, bogs, etc. Blooms of *Microcystis* in reservoirs have been responsible for the poisoning of water supplies.

Microdesmidae (wormfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of mostly marine fish with an elongate to eel-like body, small eyes, a pronounced lower jaw, and minute scales in the skin. The dorsal fin extends along most of the body, and both dorsal and anal fins are confluent with the tail-fin. Wormfish are coastal fish living partially burrowed in the coarse sand of the sea-bottom. There are about 21 species, found in tropical waters worldwide.

micro-ecosystem *See* microcosm.

micro-evolution Evolutionary change within species, which results from the differential survival of the constituent individuals in response to natural selection. The genetic variability on which selection operates arises from mutation and sexual reshuffling of gene combinations in each generation.

microfabric Structure or arrangement of mineral and organic particles on a microscopic scale, seen only with a microscope.

microfauna *See* microbiota.

microfibril More or less crystalline aggregation of cellulose molecules, at least 60 nm long and of the order of 200 nm^2 in cross-section, found in the cell walls of higher plants.

microfilament Filament, 0.4–0.7 nm in diameter, composed of the protein actin. Such structures often occur in abundance immediately beneath the plasma membrane, and play a role in cell motility and cytokinesis.

microflora *See* microbiota.

Microhylidae (narrow-mouthed frogs; class Amphibia, order Anura (Salientia), suborder Diplasiocoela) Family of burrowing or nocturnal, arboreal frogs, most of which have an egg-shaped body, tapered head, and narrow mouth. The tadpoles may be free-swimming, or develop within the egg. There are many species, occurring in the Old and New World tropics.

micromere *See* blastomere.

Micromonosporaceae (order Actinomycetales) Family of bacteria which form well-developed

mycelia with branched, septate hyphae. Spores are formed singly, in pairs, or in short chains. There are six genera, with many species. Most are saprotrophs, found in soil, compost, etc.

micronephrostomal In the nephridia of Oligochaeta, applied when the upper lip of the nephridian funnel is absent.

micronutrient Organic or inorganic element or compound that is needed only in relatively small amounts by living organisms. Vitamins are the main group of organic micronutrients. *Compare* macronutrient; *see also* essential element.

micro-organism Literally, a microscopic organism. Usually taken to include only those organisms studied in microbiology—i.e. bacteria, fungi, microscopic algae, protozoa, viruses—and thus excluding other microscopic organisms such as eelworms and rotifers.

Micropharyngea *See* Tentaculata.

Micropsitta (pygmy parrots; family Psittacidae) Genus of very small parrots which have green upper-parts, blue and black tails, and heads patterned with red, blue, or yellow. The tail has stiff, protruding feather shafts, which aid the birds in climbing trees. Pygmy parrots have deep bills, long metatarsals, and long, curved claws. They inhabit mainly lowland forest; feed on lichen, fruit, seeds, and insects; and nest in termite mounds. There are six species, found in New Guinea and nearby islands.

Micropterigidae (order Lepidoptera, suborder Zeugloptera) Family of very small, metallic-coloured moths believed to be the most primitive of Lepidoptera. Adults are usually day-fliers, have functional mandibles (rare in Lepidoptera), and feed on pollen. The venation is similar in forewing and hindwing. Larvae may feed on detritus. The moths are widely distributed, but with few species. The family includes the oldest fossil lepidopteran, which was found in Cretaceous amber.

Micropterus salmoides (large-mouth bass) *See* Centrarchidae.

micropyle (adj. micropylar) **1** Canal in the coverings of the nucellus, through which the pollen tube passes during fertilization. Later, when the seed matures and starts to germinate, it serves as a minute pore through which water enters. **2** Pore in the egg membrane of an insect oocyte, which allows sperm to enter and fertilize the egg.

microsome Small, membrane-bound vesicle formed from the endoplasmic reticulum in large numbers following the homogenization of cells. Microsomes may or may not bear ribosomes, depending upon the type of endoplasmic reticulum from which they are derived.

microspecies Population of uniparental plants that is genotypically uniform and has recognizable phenotypic expression; in both respects it is distinctive within its own uniparental group.

microsporangium Sporangium (e.g. in ferns and the clubmoss *Selaginella*) that produces numerous minute spores that germinate to produce only male gametophytes. Those pteridophytes that produce them also produce megasporangia containing few (often only 1–4) large spores. These spores germinate to produce the female gametophytes. *See also* heterospory.

microspore First cell of the male gametophyte generation of angiosperms and gymnosperms (seed plants), later to form the pollen grain. Also the smaller of two kinds of spore produced by heterosporous forms.

Microsporidea (subphylum Cnidospora) Class of protozoa which live parasitically inside the cells of a wide range of invertebrates and some lower vertebrates. There is one order, divided into two suborders. The class includes *Nosema*, species of which cause diseases of economic importance in silkworms and honeybees.

microsporophyll **1** Leaf or modified leaf of plants which bear microsporangia. **2** In angiosperms, the stamen.

microtherm Plant of cool-temperate environments, in Alphonse de Candolle's (1874) classic temperature-based scheme of world vegetation zones.

microthermal climate Low-temperature climate of short summers, defined in the Köppen classification as having mean winter temperatures of less than −3 °C. Examples include the cold boreal forest climate types in continental interiors, and along some eastern seaboards in latitudes 40–65°. The term is also applied in the Thornthwaite classification according to potential-evapotranspiration and moisture-budget criteria. *See also* Köppen climate classification; and Thornthwaite climate classification.

microtidal Applied to coastal areas in which the tidal range is less than 2 m. Wave action dominates the processes active in microtidal areas, e.g. the Mediterranean Sea and the Gulf of Mexico.

microtubule Tubular structure, 15–25 nm in diameter, of indefinite length, and composed of subunits of the protein tubulin. It occurs in large numbers in all eukaryotic cells, either freely in the cytoplasm, or as a structural component of organelles (e.g. centrioles, cilia, and flagella). Microtubules appear to function in the motility of cells, the maintenance of cell shape, and the transport of materials within cells. In addition, they form part of the structure of the mitotic spindle (responsible for the movement of chromosomes during cell division), and have been implicated in sensory transduction in some receptor cells.

microvillus Small, finger-like projection. Microvilli are found in large numbers on the free surfaces of many cells. They serve to increase the surface area of a cell and are a particular feature of those with an absorptive function, e.g. the epithelial cells of the intestine, and renal tubules.

microwhipscorpions *See* Palpigradi.

middle-arctic tundra The middle-arctic belt of the tundra. The tundra vegetation at this latitude is intermediate in floristic composition and luxuriance of development between that of the low-arctic and high-arctic.

middle ear In tetrapods, except for Urodela, Apoda, and snakes, the central chamber of the ear, derived from a gill pouch, lying between the tympanic membrane and the inner ear, linked to the pharynx by the eustachian canal, and containing the ear ossicles. In most mammals it is encased in the bulla.

mid-latitude mixed forest Forest comprising coniferous and broad-leaved trees, and belonging to one of two broad categories: (a) ecotone mixed forest, which has characteristics transitional between those of the two great belts of boreal coniferous forest and mid-latitude broad-leaved deciduous forest; and (b) a second type that seems to have the status of true climatic climax, in which both the conifers and broad-leaved trees are evergreens. These evergreen mixed forests were once extensive in the Mediterranean basin, and in the southern hemisphere are found in Chile, S. Brazil, Tasmania, northern New Zealand, and the Cape Province, S. Africa.

mid-oceanic ridges Long, linear, elevated, volcanic structures on the beds of some oceans, often lying in the middle of the ocean. They tend to occupy central positions because the oceans have formed by the symmetrical spreading of two lithospheric plates. Oceanic ridges occur in all the Earth's oceans, but may be offset from a central position, e.g. the E. Pacific ridge.

midwife toad *See Alytes obstetricans*.

Mielichhoferia *See* copper mosses.

Mie scattering Scattering of electromagnetic radiation, much in a forward direction, by spherical particles. The theory was proposed by G. Mie in 1908. *See also* Rayleigh scattering.

migmatite Certain gneissose rocks which look like mixed rocks. They are coarse-grained and heterogeneous, comprising igneous and metamorphic rocks. Generally they occur in high-grade metamorphic terrains.

mignonette (*Reseda odorata*) *See* Resedaceae.

migration 1 Movement of individuals or their propagules (seeds, spores, larvae, etc.) from one area to another. Three cases may be distinguished: (a) emigration, which is outward only; (b) immigration, which is inward only; (c) migration, which in this stricter sense implies periodic two-way movements to and from a given area and usually along well-defined routes. Such migratory movement is triggered by seasonal or other periodic factors (e.g. changing day-length), and occurs in many animal groups. 2 In plant succession, specifically the arrival of migrating propagules (migrules) at a newly denuded area.

migration route Link between two biogeographical regions that permits the interchange of plants and/or animals. Various types are recognized in the literature: for example, G. G. Simpson's (1940) 'corridors', 'filters', and 'sweepstakes routes' are widely referred to in connection with mammalian, and more recently reptilian, migrations.

migratory locust (*Locusta migratoria*) *See* locust.

migrule *See* migration.

mildew Any fungal disease of a plant in which the mycelium of the causal agent is visible as white or pale-coloured patches on leaves etc. *See also* downy mildew; and powdery mildew.

milfoils *See Myriophyllum*; and Haloragidaceae.

Milichiidae (class Insecta, order Diptera, suborder Cyclorrapha) Small family of flies, in which the adults are very small to small, and greyish-black or shining black. The third antennal segment is normally short and rounded, but is sometimes enlarged. The wing has the costa interrupted at the humeral cross-vein and the end of R_1, vein Sc is reduced, and cell Cu_1 and vein 1A are absent. Postvertical bristles on the head are convergent. The larvae are basically scavengers in the nests of ants and birds, but a few species have larvae which feed on fungi. Adults of the genus *Carnus* are parasitic upon birds. The family is distributed throughout the world. 250 species have been described. *See also* venation.

milk cap Common name for the fruit body of a fungus of the genus *Lactarius*. When damaged, such fruit bodies exude a milky latex.

milkfish (*Chanos chanos*) *See* Chanidae.

milk sugar *See* lactose.

milk-tree (cow-tree, *Brosimum galactodendron*) *See Brosimum*.

milkweeds *See Asclepias*.

milky disease Fatal disease of the Japanese beetle (*Popillia japonica*) caused by *Bacillus popilliae* or *B. lentimorbus*.

millepores *See* Milleporina.

Milleporina (massive hydrocorals, millepores; class Hydrozoa) Order of Cnidaria whose members build massive, calcareous exoskeletons, which have pores through which the polyps protrude. The medusae are free but degenerate and are formed in special cavities. Milleporina are known from the Upper Cretaceous to Recent.

Millericrinida (sea-lilies; class Crinoidea, subclass Articulata) Order of sea-lilies, which possess a stout cup consisting of basals and radials only (i.e. which is monocyclic). The long column is cylindrical in section and is distally attached to the substrate by a root-like structure or disc. The order is known from the Middle Triassic to Recent.

Millericrinina (sea-lilies; subclass Articulata, order Millericrinida) Suborder of sea-lilies in which the cup is large, with a large central cavity, and made up of five basals and five radials. The proximal brachials are in contact laterally and form part of the theca. The column is stout and cylindrical in section, increasing in diameter towards the cup. The suborder is known from the Middle Triassic to Lower Cretaceous.

millerite Mineral, specific gravity 5.2–5.6, hardness 3.0–3.5, chemical composition NiS, named after the British mineralogist W. H. Miller. It occurs as tufts of radiating fibres in cavities, and as

replacement for other nickel minerals. It also occurs in veins carrying nickel minerals and other sulphides, and around some volcanoes as sublimation products. It is distinguished by its colour, slender, acicular crystals, and the elastic nature of the crystals. It is brass-yellow and opaque, and has a greenish-black streak and a metallic lustre. It crystallizes in the trigonal system. The crystals are usually long, slender, acicular, and in radiating groups. It is an important ore of nickel.

Millettia (family Leguminosae, subfamily Papilionatae) Genus of trees and big woody climbers in which the leaves are usually pinnate. The pods are sometimes tardily dehiscent, the seeds large. The timber, with interlocking grain, is not used. There are 150 species.

millibar *See* bar.

milli-equivalent One-thousandth of an equivalent weight.

milt Mass of spermatozoa and other secretions of the sperm ducts exuded by male fish during spawning, or during copulation in the case of the live-bearing species.

Mimetidae (order Araneae, suborder Araneomorphae) Family of spiders which are predatory on other spiders, and have a characteristic row of large setae on the first pair of legs. Species of the genus *Evo* hang under leaves and catch passing spiders by extension of their long legs. Other species invade spider webs, and some lure males of other species to their deaths by imitating the courtship display of the spider concerned.

Mimidae (mockingbirds, thrashers; order Passeriformes) Family of blue-grey, grey, or brown birds, one species of which is entirely black. Some have black-spotted under-parts. They have medium to long bills; some have highly decurved, short, rounded wings; and they have long tails. They sing well, and many are mimics. They are arboreal and terrestrial, found in trees and dense scrub, feeding on insects, fruit, and seeds, and nesting in trees and bushes, or on the ground. There are 13 genera, with about 32 species, some migratory, found in N., C., and S. America, and the W. Indies.

Mimosa (family Leguminosae, subfamily Mimosoideae) Genus mainly of herbs and shrubs, in which the stipules are sometimes thorn-like. The leaves are multipinnate. *M. pudica* (the sensitive plant) has leaflets which droop on shaking. There are 500 species, occurring in the tropics, mainly in America.

Mimosoideae One of the three subfamilies of Leguminosae, of mainly woody plants, in which the leaves are often bipinnate. The flowers are regular; the sepals and petals are free and valvate; the stamens are commonly numerous. There are 56 genera, found mainly in the tropics.

Mimus (mockingbirds; family Mimidae) Genus of grey or brown birds which have whitish under-parts, and often a white supercilium. They have long tails with white tips and white outer feathers, and many have white wing-bars. Most are good mimics. There are nine species in N., C., and S. America, and the W. Indies. *M. polyglottus* (northern mockingbird) is a migrant.

Mimusops (family Sapotaceae) Genus of trees in which the leaves are stipulate. There are eight sepals, 24 petals, and eight stamens. *M. elengi* is a handsome ornamental, and also has medicinal properties. There are 20–30 species, occurring in the Old World tropics.

Mimus polyglottus (northern mockingbird) *See Mimus*.

mineral Inorganic substance which occurs naturally, and typically has a crystalline structure whose characteristics of hardness, lustre, colour, cleavage, fracture, and relative density can be used to identify it. Each mineral has a characteristic chemical composition. Rocks are composed of minerals. More loosely, certain organic substances obtained by mining are sometimes termed 'minerals'.

mineral cycle Biogeochemical cycle, in which elements move through the soil, living organisms, air, and water, or through some of these.

mineralization Conversion of organic tissues to an inorganic state as a result of decomposition by soil micro-organisms.

mineral soil Soil composed principally of mineral matter, in which the characteristics of the soil are determined more by the mineral than by the organic content.

minimal area The smallest area that can contain the species representative of a particular plant community. When the number of species recorded in increasingly larger sample units is plotted graphically (to give a species–area curve) the minimal area is the point at which the curve becomes horizontal. In practice, the curve rarely becomes truly horizontal because of natural heterogeneity, and some subjective assessment of the minimal area is made, based on the species–area curve. Alternatively, the 'minimum quadrat number' may be defined as the 'equivalence point', i.e. the point at which the number of species and the number of quadrats are equal.

minimum quadrat number *See* minimal area.

minimum temperature The lowest temperature recorded—diurnally, monthly, seasonally, or annually, or the lowest temperature of the entire record. Daily air-temperature minima are recorded by the screen minimum thermometer. *See also* grass minimum temperature.

minimum thermometer Thermometer that records the lowest temperature to which it has been exposed, e.g. by allowing a fall of mercury past a restriction in the tube, but preventing the mercury's return on expansion. It is most commonly used to record minimum daily temperatures.

mining bees 1 (desert mining bees) *See* Fideliidae. 2 (solitary mining bees) *See* Andrenidae. 3 (tawny mining bee) *See Andrena fulva*.

minivets *See* Campephagidae.

mink (*Mustela*) *See* Mustelidae.

minke whale (lesser rorqual, *Balaenoptera acutorostrata*) *See* Balaenopteridae.

minnow *See* Cyprinidae.

mint *See Mentha*.

mintbushes *See Prostanthera*.

Miocene Fourth of the five epochs of the Tertiary Period extending from the end of the Oligocene, 24 million years ago, to the beginning of the Pliocene 19 million years later. Many mammals with a more modern appearance evolved during this epoch, including deer, pigs, and several elephant stocks.

Mirabilis jalapa (four-o'clock plant) *See* partial dominance.

Mirafra (bush larks; family Alaudidae) Genus of rufous, brown, or grey larks, which have streaked backs and under-parts. They inhabit areas of scrub and bushes, often perching on trees. They are fast runners, and clap their wings in their courtship flight. They feed on insects and seeds, and nest on the ground, many building domed nests. There are 26 species, found in Africa, Asia, and Australia.

mirage Optical effect in which major vertical variation in temperature of the lower atmosphere produces differential refraction of light, resulting for example in raised images and in gaps, which may give the appearance of a water surface.

mire General term for a wetland area and its associated vegetation, applied most often to peaty areas.

Miridae (capsid bugs, leafbugs; order Hemiptera, suborder Heteroptera) Family of bugs which live on plants. Some are predators; others feed on plants. The family includes some destructive pests of both temperate and tropical crops. There are more than 5000 species, distributed worldwide.

mirror yeast Ballistospore-forming yeast of the family Sporobolomycetaceae.

misfit stream (underfit stream) Stream that is too small to have cut the valley it currently occupies. Applies particularly to a meandering stream whose dimensions are much smaller than those of the meandering valley through which it flows.

Misgurnis fossilis (weatherfish) *See* Cobitidae.

mispickel *See* arsenopyrite.

mis-sense mutant In genetics, a mutant in which a codon has been altered by mutation so that it encodes a different amino acid. The result is almost always the production of an inactive or possibly unstable enzyme.

missing-plot technique Standard formula for the estimation of a missing datum observation (or, with suitable modification, the estimation of several missing values) in the analysis of the variance of data collected according to a recognized experimental design. The missing observation (x'_{ij}) may be estimated as:

$$x'_{ij} = tT'_i + bB'_j - G' \div (t-1)(b-1),$$

where T'_i, B'_j, and G' are the treatment, block, and grand totals for the available observations, i is the ith treatment, j is the jth block, t is the number of treatments, and b is the number of blocks.

Mississippian *See* Carboniferous.

mist Surface-layer atmospheric condition in which visibility is reduced by very fine, suspended water droplets. In synoptic meteorology, the relative humidity in a mist condition is more than 95% and overall visibility is at least 1 km. *See also* haze; and fog.

mistletoe (*Viscum*) *See* Loranthaceae.

mistletoebird (*Dicaeum hirundinaceum*) *See Dicaeum*.

mistral Strong, cold, northerly wind that blows offshore with great frequency along the Mediterranean coast from N. Spain to N. Italy, and that is particularly frequent in the lower Rhône valley. The wind may persist for several days, and is best developed when a depression is forming in the Gulf of Genoa to the east of a ridge of high pressure. The airstream that feeds the mistral is commonly derived from polar air of maritime origin. In the Rhône valley and similar areas of occurrence, the airflow is strengthened by katabatic and funnelling effects to produce speeds of up to 38 metres per second compared with the typical 20.5 metres per second experienced along the coast.

Misumena vatia *See* Thomisidae.

mites *See* Arachnida.

mitochondrion Oval, or occasionally round or thread-shaped, organelle, whose length averages 2 μm, and that occurs in large numbers in the cytoplasm of eukaryotic cells. It is a double membrane-bound structure in which the inner membrane is thrown into folds (the cristae) that penetrate the inner matrix to varying depths. It is a semi-autonomous organelle containing its own DNA and ribosomes, and reproducing by binary fission. It is the major site of ATP production and thus of oxygen consumption in cells, and houses the enzymes involved in the citric-acid cycle and in oxidative phosphorylation.

mitogenic Able to induce or to stimulate mitosis.

mitosis Normal process of nuclear division (occurring at cell division) by which two daughter nuclei are produced, each identical to the parent nucleus. Before mitosis begins each chromosome replicates; these daughter chromosomes then separate during mitosis so that one duplicate goes into each daughter nucleus. The result is two daughter nuclei, each with an identical complement of chromosomes and hence of genes. Mitosis is generally divided into four phases: prophase, metaphase, anaphase, and telophase. During prophase, chromosomes become visible within the nucleus because they shorten, thicken, and coil up as a spiral. Each chromosome is longitudinally double except in the region of the centromere, and each single strand of the chromosome is called a chromatid. The nucleolus and nuclear membrane disappear. In metaphase the chromosomes move within the spindle connecting the two centrosomes (formed by division of the centriole into two at the start of prophase, and the subsequent moving apart of these two daughter centrioles). The chromosomes finally arrange themselves along the equator

of the spindle. During anaphase, the two chromatids making up each chromosome separate as the centromere becomes functionally double, and are thus converted to independent chromosomes moving to opposite poles. During telophase, the spindle disappears, a nuclear envelope reappears around each of the two groups of daughter chromosomes, the chromosomes return to their extended state, and the nucleoli reappear. This is followed by cytoplasmic division (cytokinesis) into two parts—by a cleavage furrow in the case of animal cells or by a cell plate in the case of plant cells. The final result is two daughter cells with identical nuclear contents. *Compare* meiosis.

mitotic spindle The spindle-shaped system of microtubules that, during cell division, traverses the nuclear region of eukaryotic cells. The chromosomes become attached to it and it separates them into two sets, each of which can be enclosed in the envelope of a separate daughter nucleus.

Mitrasacme (family Loganiaceae, tribe Spigelieae) Genus of shrubs and herbs with opposite, entire leaves and regular flowers. The fruit is a capsule or berry. There are 35 species, of which many are components of grass and sedge communities of coastal plains, marshland habitats, and alpine herbfields. They are found in Australia, New Zealand, and E. Asia.

mixed cloud Cloud containing unfrozen water droplets as well as ice crystals. Typically the condition is found in cumulonimbus, nimbostratus, and altostratus.

mixed sorus *See* gradate sorus; and sorus.

mixed woodland Woodland in which the minority of trees, but amounting to not less than 20% of all the trees, are either coniferous or broad-leaved.

mixing condensation level The vertical mixing of air, e.g. in the amalgamation of air masses with different temperatures, leading to conditions of oversaturation and condensation. The mixing condensation level is the lowest level at which condensation can occur.

mixing depth The extent of an atmospheric layer measured from the surface of the Earth, usually a sub-inversion layer, in which convection and turbulence lead to mixing of the air and any pollutants in it.

mixing ratio Ratio of the mass of a given gas (e.g. water vapour) to that of the remaining gas (e.g. dry air) in the mixture. The examples given yield the 'humidity mixing ratio', expressed most conveniently in grams per kilogram of dry air. *See also* specific humidity.

Mixosaurus atavus Possibly the earliest representative of the mixosaurs, which were the first of the fish lizards (ichthyosaurs). *Mixosaurus atavus* is recorded from the Triassic of Germany. Unlike *Ichthyosaurus*, the mixosaur tail lacked the strong development of the fish-type of caudal fin.

mixotroph Organism in whose mode of nutrition both organic and inorganic compounds are used as sources of carbon and/or energy.

Mlanji cedar (*Widdringtonia whytei*) *See Widdringtonia*.

Mn *See* manganese.

mnemon Memory unit within the brain associated with a particular sensory system and with a particular set of behavioural responses to stimuli received by that system.

Mnium (order Bryales) Genus of mosses, in which the ovate or lanceolate leaves have a border of long, narrow cells, with double teeth along the leaf margins (visible under the microscope). There is a nerve which ends in the leaf tip with a tooth at the back. There are about 12 species, found mostly in the northern hemisphere. *M. hornum* is one of the most abundant of British mosses, forming extensive carpets in woodland on peaty acidic soil, rotting wood, etc. Normally it is a dull, dark green, although the young shoots that grow in spring are a contrasting bright green. (A number of species formerly included in this genus are now allocated to other genera: e.g. *M. undulatum* is now called *Plagiomnium undulatum* and *M. punctatum* is now *Rhizomnium punctatum*.)

Mo *See* molybdenum.

moas *See* Dinornithidae.

moazagotl *See* lee wave.

mobbing Harassment of a predator by members of a prey species.

Mobilina (order Peritrichida) Suborder of ciliate protozoa which do not have stalks and are motile. The cell has a modified posterior region which forms a complex adhesive disc. Mobilina are found in association with aquatic animals.

Mobulidae (manta, devil ray; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Small family of marine rays which generally are of large size. The very large pectoral fins spread out like wings, pointed at the tips. A small dorsal fin is located above the base of the whip-like tail, which has no tail-fin. The two flap-like appendages extending forward on each side of the mouth, which assist in the uptake of food, are characteristic for the family. Perhaps the largest of the devil rays is *Manta birostris* (giant manta), with a 'wing-span' that may exceed 6.2 m. It is a non-aggressive, harmless species, feeding mainly on tiny planktonic animals. There are about 10 species, distributed worldwide in tropical and subtropical waters.

Mochokidae (upside-down catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of freshwater catfish which have, typically, three pairs of feathery barbels around the mouth, an unusually large adipose fin behind the single dorsal fin, and a strongly forked tail-fin. Several species, including *Synodon schall* (40 cm) and *S. nigriventris* (7 cm) often swim on their backs (upside-down), perhaps in search of insects at the water surface. They are well known to aquarium hobbyists. There are about 150 species, found in Africa.

mockingbirds *See* Mimidae; and *Mimus*.

mock orange *See Philadelphus*.

model Representation of reality in which the main features of some aspect of the real world are presented in simplified terms in order to make that aspect easier to comprehend, and often to facilitate the making of predictions.

modern synthesis (neo-Darwinism) Darwin showed that evolution involves selection interacting with variation within populations, but he did not know that the bases of this variation are discrete units of heredity, or genes. This was discovered by Mendel. The fusion of Mendelian genetics and Darwin's natural selection is referred to as the modern synthesis. A further synthesis has been achieved in recent years with the incorporation of knowledge of evolution at the molecular level.

modifier Gene that modifies the phenotypic expression of another gene.

Modiomorphoida (phylum Mollusca, class Pelecypoda) Order of entirely marine pelecypods, which have an oval shell shape whose microstructure is unknown. The subclass is not well understood, but it is ancestral to most of the later heterodont pelecypods. They first appeared in the Middle Cambrian, and died out in the Lower Permian.

Moeritherioidea (superorder Paenungulata, order Proboscidea) Extinct suborder of subungulates known from the Upper Eocene and Lower Oligocene in Africa. The beginning of tusk formation from the second incisors can be recognized, and the dentition was modified by the formation of a diastema and the loss of the lateral lower incisor, the lower canine, and the first premolar. The animal was about the size of a modern tapir, with a long body, short legs, and a flexible snout. It may have inhabited marshes, and may have been amphibious.

Moeritherium lyonsi First of the 'elephant' (proboscidean) line. It was an Upper Eocene mammal with short legs and a long trunk.

Moho *See* Mohorovičić discontinuity.

Mohorovičić discontinuity (Moho) Seismically defined boundary separating the crust from the upper mantle. It is named after the Serbian geophysicist A. Mohorovičić.

moisture balance *See* moisture budget.

moisture budget (moisture balance) The balance of water, as represented broadly by the equation: precipitation = run-off + evapotranspiration + the change in soil-moisture storage. Over the year, for example in mid-latitudes, the budget is balanced by a high level of potential evapotranspiration and utilization of soil moisture in summer, compensated by a water surplus and recharge of soil moisture in winter, when evaporation is less and precipitation is sometimes greater.

moisture index The term used instead of 'moisture budget', e.g. by C. W. Thornthwaite (1955), and calculated from the aridity and humidity indices, as $I_m = 100 \times (S-D)/PE$, where I_m is the moisture index, S is the water surplus, D is the water deficit, and PE is the potential evaporation.

mojarra *See* Gerreidae.

Mola mola (sunfish) *See* Molidae.

molar In mammals, one of the posterior teeth, commonly used for crushing, that are not preceded by milk teeth. Usually molars have several roots and their biting surface is formed from patterns of projections and ridges.

molariform row In mammals, a row of similarly formed premolar and molar cheek teeth all of which are used for crushing.

mold *See* mould.

mole *See* Talpidae.

mole crickets *See* Gryllotalpidae.

molecular clock The idea that molecular evolution occurs at a constant rate, so that the degree of molecular difference between two species can be used as a measure of the time elapsed since they diverged. Its accuracy depends on the validity of the neutral-mutation theory.

molecular evolution Substitution of one amino acid for another in protein synthesis as a result of mutation of the genetic code. According to the neutral-mutation theory of molecular evolution, the variability at the molecular level which results from mutation is caused by random drift of the mutant genes rather than by selection.

molecule *See* covalent bond.

mole drain Drain that can be made in soils by pulling a bullet-shaped device through the soil so that the compacted sides of the tunnel maintain that form for several years.

mole rat *See* Bathyergidae; and Spalacidae.

mole salamanders *See* Ambystomatidae.

Molidae (sunfish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Small family of marine fish with a very peculiar body profile—they seem to be all head and no body. Head and body actually are very deep, the body short and ending in a tail-fin that is no more than a narrow band without a caudal peduncle. The pectoral fins are small, the pelvic fins are absent, but the dorsal and anal fins are long and provide the major locomotory thrust. The largest species, *Mola mola* (sunfish), may grow to 3 m, reaching a weight of some 1400 kg; the other species are smaller, but also live in the open ocean. Probably there are three species, occurring in tropical and subtropical seas.

mollic horizon Surface horizon of mineral soil that is dark in colour, and relatively deep, and contains at least 1% organic matter, or 0.6% organic carbon, the determination of either being acceptable. It is the diagnostic horizon of Mollisols (USDA) and is associated with base-rich materials and grassland vegetation.

Mollicutes (mycoplasmas, PPLOs) Class of prokaryotic organisms in which the cells have no cell walls. Sometimes they are regarded as bacteria, sometimes as a separate prokaryotic group. Species may be saprotrophic, parasitic, or pathogenic.

There is one order, Mycoplasmatales, and two families, Acholeplasmataceae and Mycoplasmataceae.

Mollisols Mineral soils, an order of the USDA Soil Taxonomy, that are identified by a deep mollic surface horizon (well-decomposed and finely-distributed organic matter) and base-rich mineral soil below.

Mollusca (molluscs) Phylum of coelomate invertebrates comprising classes which are morphologically quite diverse, including the gastropods, cephalopods, bivalves, ammonites, and belemnites. Shell material is secreted by the mantle covering the visceral hump. Calcium-carbonate shells may be univalve, bivalve, or plated. Some groups have shells modified to serve as internal skeletons. Most have a well-differentiated head, with radula and salivary glands. A ventral muscular foot is very common. The anus and kidneys open into the mantle cavity. The alimentary canal usually has a buccal mass. A heart and an arterial and venous system are present, and there are paired ctenidia for respiration. The nervous system is ganglionic. Most Mollusca are aquatic. They first appeared in the Lower Cambrian. There are six extant and three extinct classes, with more than 80 000 species.

molluscs *See* Mollusca.

Moloch horridus (thorny devil; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Species of bizarre, spiny, agamid lizards of the Australian desert. The body is 18–20 cm long. Enlarged spines form protective horns on the forehead. The jaws are weak. Food consists exclusively of termites and ants.

Molossidae (free-tailed bats; order Chiroptera, suborder Microchiroptera) Family of insectivorous bats in which the thick tail is surrounded by the uropatagium, which forms a loose sheath, and projects below the edge of the uropatagium when the animal is at rest. The nose is simple,-with no leaf, and in most species overhangs the jaw. The ears are heavy-looking and deeply folded. Molossids often form very large colonies in caves and roofs. They are of worldwide tropical and subtemperate distribution. There are about 12 genera, with about 90 species.

Molothrus (cowbirds; family Icteridae) Genus of medium-sized, black birds which have glossy, bronze or blue iridescence, and stout, conical bills. They inhabit open country and grassland, and feed on insects and seeds. They are brood parasites, except for *M. badius* (bay-winged cowbird) which is parasitized by *M. rufoaxillaris* (screaming cowbird). There are five species, found in N., C., and S. America, and the W. Indies.

Molothrus badius (bay-winged cowbird) *See Molothrus*.

Molothrus rufoaxillaris (screaming cowbird) *See Molothrus*.

Molpadiida (subclass Apodacea) Order of holothuroids which have respiratory trees. A few tube-feet form a ring around the anus.

Molva molva (European ling, ling) Species of large (2 m or more) edible fish, rather eel-like in appearance, distributed widely in deep water in the N. Atlantic. *See also* Gadidae.

molybdenite Mineral, specific gravity 4.6–4.8, hardness 1.0–1.5, chemical composition MoS_2, whose name is derived from the Greek for 'lead'. It is quite widespread but seldom occurs in large quantities. It is found as an accessory mineral in granites, quartz veins, and pegmatites, in contact metamorphic zones with garnets, pyroxenes, scheelite, pyrite, and tourmaline, and in veins with scheelite, wolframite, cassiterite, and fluorite. It is distinguished by its greasy feel and by its specific gravity, which is higher than that of graphite. It is pale bluish to lead-grey, and has a greenish-grey streak and a metallic lustre. It crystallizes in the hexagonal system. The crystals are hexagonal, often tabular grains, and it also occurs as foliated and scaly masses. It is a major ore mineral for molybdenum.

molybdenum (Mo) Element required in small amounts by plants and found largely in the enzyme nitrate reductase. A symptom of deficiency is interveinal chlorosis.

Momotidae (motmots; order Coraciiformes) Family of mainly bright green and blue birds which have black ear patches. They have strong, decurved bills and syndactylous feet, and in most the two, long, central tail feathers have bare shafts and raquet-shaped tips. Motmots are found in forests, feed on insects and fruit, and nest in holes in banks. There are six genera, with nine species, found in tropical C. and S. America.

Monacanthidae (filefish, leatherjacket; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Family of deep-bodied marine to estuarine fish in which the first dorsal fin can be locked in an upright position by the small second spine. Several species, e.g. *Nelusetta ayraudi* (chinaman leatherjacket) of Australia, are valuable food fish. There are about 85 species, which recently have been accommodated in the family Balistidae.

monadnock Isolated hill or range of hills standing above the general level of a peneplain and resulting from the erosion of the surrounding terrain. It may be located on relatively resistant rock or on a watershed position where erosion is reduced. It is named after Mount Monadnock, New Hampshire, USA.

Monarcha (monarchs; family Muscicapidae) Genus of grey, black, blue, red, and white flycatchers which have fairly stout, broad bills. They inhabit woodland and forest, feed on insects mainly caught on branches and leaves, and nest in trees. There are about 30 species, found in New Guinea, Australia, Indonesia, and the Solomon Islands.

monarchs *See Monarcha*.

monazite A mineral, specific gravity 4.9–5.4, hardness 5–5.5, chemical composition $(Ca,La,Th)PO_4$, whose name is derived from the Greek for 'solitary'. It is found extensively as an accessory

mineral in granites and pegmatites, and also in gneisses and carbonatites. It is found concentrated in alluvial sands and placers. It is distinguished from zircon by its colour and by being softer. It is clove-brown to reddish-brown to orange and green, and has an off-white streak, and a resinous to waxy lustre. It crystallizes in the monoclinic system. The crystals are small, short, prismatic to tabular grains, with larger crystals showing striated faces. It is used as a source of cerium, thorium, and other rare-earth metals and compounds.

Monera One of the five kingdoms of life, comprising the prokaryotic Cyanophyta (blue-green algae) and bacteria (Schizomycophyta). The bacteria were the first forms of life on Earth, dating from at least 3300 million years ago, while the first cyanophytes appeared about 2600 million years ago.

money spiders *See* Linyphiidae.

mongooses *See* Viverridae.

monilliform Resembling a string of beads.

Monimiaceae (order Laurales) Family of evergreen trees and shrubs, with opposite leaves, including many aromatic species. The flowers may be solitary or in inflorescences, often unisexual, with variable numbers of overlapping perianth segments. The fruit is a dry achene. The family includes species used to produce aromatic oils, perfumes, medicines, and dyes. Some species are used locally for timber or edible fruits. There are 30 genera and about 450 species, occuring in the tropics.

monitors *See* Varanidae.

monkey *See* Catarrhini; Ceboidea; Cercopithecidae; and Platyrrhini.

monkey grasshopper *See* Eumastacidae.

monkeynut (*Arachis hypogaea*) *See Arachis*.

monkey puzzle *See Araucaria*.

monkfish (*Squatina squatina*) *See* Squatinidae.

monoallelic In genetics, applied to a polyploid in which all alleles at a particular locus are the same.

Monobathrida (subclass Camerata) Order of Palaeozoic crinoids which have only one circlet of plates beneath that which bears the arms. They range from Lower Ordovician to Upper Permian in age.

Monoblepharidales (class Chytridiomycetes) Order of microscopic fungi in which the thallus is filamentous and eucarpic. Asexual reproduction involves the formation of zoospores in cylindrical or flask-shaped sporangia. There are three genera, found on twigs, etc., submerged in water.

monocaryon *See* monokaryon

monocentric (mycol.) Applied to a thallus with a single reproductive centre.

Monocentridae (pinecone fish, knight fish; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of marine fish, short but deep-bodied and coveped by heavy plate-like scales. The eyes are large, but the fins are small, with the first dorsal fin consisting of at least four strong, membrane-free spines. They are in demand as an aquarium fish. They live in small schools, hiding in caves during the day. One of the better-known species, *Cleidopus gloriamaris*, grows to 22 cm. There are two species, found in the Indo-Pacific region.

Monocirrhus polyacanthus (leaf-fish) *See* Nandidae.

mono-climax theory *See* climax theory.

monocline In geology, a one-limbed flexure on either side of which the strata are horizontal or dip uniformly at low angles.

monocondylar With a single articulation.

monocotyledon (Monocotyledoneae) One of the two great divisions of the angiosperms (flowering plants), in which the embryo characteristically has one cotyledon, which is usually amplexicaul and, like the later leaves, has parallel nervation.

monoculture The growing over a large area of a single crop species (e.g. *Triticum aestivum*, bread wheat), or of a single variety of a particular species. Monocultures are especially vulnerable to pest and disease infestation, but uniformity of height, development, etc. in a crop facilitates management, especially harvesting. The economic and ecological wisdom of monoculture is widely debated.

Monocyathea (Regulares; phylum Archaeocyatha) Class of animals that were usually solitary, only rarely colonial, found in Lower and Middle Cambrian marine deposits. The conical cup varies from cylindrical to saucer-shaped, and usually consists of two walls. There is an intervallum containing tabulae alone or with septa. There is a fan-like divergence of longitudinal pore-rows in the septa. Dissepiments may be present.

Monocyathida (class Monocyathea (Regulares)) Order of small, solitary, rarely colonial archaeocyathids found in Lower Cambrian rocks. The cup may be either conical with one porous wall and sometimes a pelta, or sac-like and two-walled without a pelta. The order contains three suborders, with 11 families, and 15 genera.

monocyte *See* leucocyte.

monodactyl Applied to the condition (e.g. in *Thoatherium—see* Litopterna) in which the lateral metacarpals and metatarsals are reduced, leaving only one functional digit.

Monodactylidae (diamond fish, moonfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine coastal fish with a strongly compressed and deep body: the large dorsal and anal fins give the fish a diamond-shaped profile. Apart from two dark bands across the head, the body has a silvery colour, which makes *Monodactylus argenteus* (20 cm) an attractive aquarium fish. About five species occur in the Indo-Pacific region.

Monodon (narwhal) *See* Monodontidae.

Monodontidae (order Cetacea, suborder Odontoceti, superfamily Delphinoidea) Family comprising *Monodon monoceros* (narwhal) and *Delphinapterus*

leucas (beluga, or white whale), whales in which the forehead is high and rounded, there is no dorsal fin, the flippers are rounded and short, and the tail-fin is notched at the posterior margin. The beluga has 8–10 teeth in each jaw. The narwhal has two teeth. In the male, one (almost always the left) and rarely both of these may grow forward into a spiral tusk up to 2.5 m long. Narwhals are grey with black mottling, adult belugas white or near-white. Adults of both species grow to a length of about 6 m. Their diet consists of demersal and pelagic fish, and Crustacea. They are distributed throughout Arctic waters and enter the larger rivers within the Arctic Circle.

monoecious Applied to an organism in which separate male and female organs occur on the same individual: for example to a plant which bears male and female reproductive organs in the same flower, or separate male and female flowers on the same plant; or to a hermaphrodite animal. *See also* androecium; and unisexual flower.

monogamy Mating of a male with a female involving no extra individuals of either sex. Usually the bond operates through the breeding season and in some cases it may extend through the adult life of the two individuals. Examples may be found amongst several bird species, such as mute swan, sparrowhawk, and great tit.

Monogenea (phylum Platyhelminthes) Class—or in some classifications an order of the class Trematoda—of parasitic, platyhelminth worms, most of which have a gut with an intestine and pharynx. An anterior sucker mouth may be present. Mature individuals lack cilia. Most are ectoparasitic; fish are the main hosts.

Monogononitida (phylum Aschelminthes, class Rotifera) Order of mainly freshwater, aschelminth worms most of which adopt a vagile or sessile mode of life. A degree of jointing is present in the cuticle. Sexes differ morphologically.

Monograptus (class Graptolithina) The first recorded monograptid, from the Ludlovian (Lower Silurian). Successive evolutionary trends within the graptolites resulted in the development of the single-branched monograptids. These had only a limited number of thecal cups on one side of the branch although the cups were large and exhibited considerable morphological variation.

monohybrid Cross between two individuals which are identically heterozygous at one particular gene pair, e.g. $Aa \times Aa$.

monohybrid heterosis *See* heterosis; and overdominance.

monokaryon (monocaryon) Fungal mycelium or hypha in which each cell contains a single nucleus.

monomictic Applied to lakes in which only one seasonal period of free circulation occurs. In cold monomictic lakes, typical of polar latitudes, the seasonal overturn occurs briefly in summer: in other seasons surface-water temperatures are below 4 °C, so inducing density stratification. In warm monomictic lakes, typical of warm temperate or subtropical regions, the seasonal overturn occurs in winter. At other times thermal stratification, with the formation of a distinct epilimnion, prevents free circulation through the depth of the lake.

Monomorium pharaonis (Pharaoh's ant; order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Formicinae) Tramp species of ants which originated in the tropics but which is now a pest of heated buildings in temperate regions. Budding (the migration of a group of workers and brood to a new nest site) has replaced reproduction by mating flights.

monomyarian Applied to the condition in certain pelecypods in which only the posterior adductor muscle is present.

monophyletic Applied to a group of species that share a common ancestry, being derived from a single interbreeding (or Mendelian) population, as opposed to a polyphyletic group, which is derived from many such populations. If the members of a given taxon are descended from a common ancestor they are said to be 'monophyletic', e.g. the families within a class would be monophyletic if they were all descended from the same family or lower taxonomic unit. Under the strictest definition they would all have to be descended from a single species.

monophyodont Applied to animals in which the teeth are not replaced.

Monopisthocotylea (phylum Platyhelminthes, class Monogenea) Order of parasitic, platyhelminth worms which have a mouth, pharynx, and intestine. The posterior end is ciliated. They are ectoparasitic.

Monoplacophora (phylum Mollusca) Class of primitive, almost bilaterally symmetrical, univalved molluscs, whose limpet-shaped shell of calcium carbonate consists of an external periostracum, a prismatic layer, and an internal, nacreous deposit. The internal organs are metamerically segmented, and the circular foot and radula are ventrally placed. Typically Monoplacophora have paired muscle scars. All are marine, benthic filter-feeders. Fossil forms inhabited shallow water, but modern forms occur in deep water. They first appeared in the Lower Cambrian.

monoplanetism The phenomenon in some members of the Oomycetes in which there is only one motile phase and only one type of zoospore.

monopodial 1 Type of branching in which lateral branches arise from a definite main, central stem. 2 With a single axis, an extension growth from the apex.

Monopterus alba (rice eel) *See* Synbranchidae.

Monorhina Older name for the group of fish including the lampreys (Petromyzonidae) and related jawless fossils which possess a single median nostril between the eyes.

monosomic genome Genome that is basically diploid but that has only one copy of one particular chromosome type so that its chromosome number is $2n-1$. An XO human individual is monosomic for the X chromosome.

monothetic In numerical classification schemes, the use of a single criterion or attribute as the basis for each subdivision of a sample population, as for example in association analysis. *Compare* polythetic.

Monotremata (class Mammalia, subclass Prototheria) Order comprising the duck-billed platypus (*Ornithorhynchus anatinus—see* Ornithorhynchidae) and the echidnas or spiny ant-eaters (*Tachyglossus* and *Zaglossus—see* Tachyglossidae). There were some extinct forms of which very few are known, though of those some attained large sizes. The echidnas have no fossil record older than the Pleistocene, but a fossil platypus, *Obdurodon insignis*, is known from the Miocene. In view of their reptilian affinities they are thought to represent a separate and direct line of descent from the earliest Mesozoic animals, possibly the docodonts, independent of the line leading to other mammals. They retain many primitive features and are quite unlike marsupials or eutherians. The rectum and urinogenital system open to a common cloaca, from which the name 'monotreme' is derived (although the feature is shared by marsupials and some insectivores). The male is heterogametic as in other mammals. The young are hatched from large, yolky eggs, incubated in a nest by the female platypus and in a pouch in the echidnas. The embryos develop a caruncle and egg-tooth. After hatching they are fed milk secreted by the female from specialized sweat glands which do not open through central nipples. The diaphragm is fully developed, and the heart possesses a single left aortic arch as in other mammals. The larynx is developed, and monotremes make sounds. The tarsus of the male has a grooved erectile spine to which (in the platypus) poison is fed from a gland in the thigh. The poison (said to be capable of killing a dog) may serve to immobilize the female during mating. Adults lack teeth but possess bills. The skull is specialized but retains primitive features. The jaw consists of a single bone. The cervical ribs are not fused, the shoulder girdle is reptilian in form, the pelvis is reminiscent of that of marsupials. The body is covered with hair, in the echidnas partly modified into spines on the back. The limbs are modified for digging. Echidnas hibernate, and in hot weather all monotremes shelter in burrows or caves. Monotremes are known only from Australia and New Guinea, where they may have survived because of their high degree of specialization and geographical isolation.

monoxenous *See* autoecious.

monozygotic twins Twins that are formed at some time during early development by the fission into two of the embryo derived from a single fertilized egg. Such twins are genetically identical and therefore also of the same sex. *Compare* dizygotic twins.

monsoon From the Arabic *mausim* (season), a seasonal change of wind direction and properties associated with widespread temperature changes over land and water in the subtropics. Seasonal alternations of pressure systems together with shifting upper wind patterns and jet streams produce seasonal winds, called 'monsoon winds'. The climate of the Indian subcontinent is especially characterized by the monsoon, where a distinct rainy season occurs in the SW monsoon. Other major areas of monsoons are E. and SE Asia, the W. African coast (latitude 5–15° N) and N. Australia.

monsoon forest Tropical forest with a marked seasonal rhythm induced by alternating wet and dry seasons typical of the true monsoon lands. Most of the trees lose their leaves in the dry season, but since many of them also flower at this time, the 'wintry' aspect is far less marked than in higher latitudes.

Monstera (family Araceae) Genus of 50 species of tropical American climbers, some with holes in the leaves. The fruit of *M. deliciosa*, a common house plant, is edible.

monster anglerfish *See* Linophrynidae.

montane forest Forest in the montane zone of tropical and middle latitudes. It differs in floristic composition and ecological character from that found at lower elevations in the same latitude, and in both respects often has strong affinities with forest found in the lowlands of adjacent higher latitudes.

montbretia *See Crocosmia*.

month degrees The excess of mean monthly temperatures above 6 °C (43 °F), added together and used as accumulated temperature (indicative of conditions for vegetation growth) in some climate classifications (e.g. that of A. Miller, 1951).

Monticola (rock thrushes; family Turdidae) Genus of medium-sized birds in which most males have a blue-grey head and back, with chestnut underparts, and females are mottled brown. They inhabit open, rocky areas, scrub, and dry forest, feed mainly on insects, seeds, and berries, and nest in rock crevices. There are 10–12 species, most migratory, found in Europe, Africa, and Asia.

Montlivaltia Solitary scleractinian coral commonly found in rocks of Mesozoic age. It is usually conical or cylindrical in shape with prominent elongate septa. *Montlivaltia* is known worldwide.

montmorillonite Mineral, specific gravity variable between 2.0 and 2.7, hardness 2, chemical composition $(Mg,Ca)OAl_2O_35SiO_2.nH_2O$, which is named after an area in France and which is found very extensively. It results from the decomposition of volcanic ashes in marine basins, and also occurs in the weathering crust of basic igneous rocks, e.g. diabases, basalts, gabbros, and peridotites. It is distinguished by its strong swelling activity with wetting, and its greasy feel. It is white to grey with tints of blue, pink, pink-red, and green, and has a dull lustre. It crystallizes in the monoclinic system. It usually occurs in massive, microcrystalline aggregates of very fine, scale-like crystals. It is used extensively as an absorbant, for refining out suspended matter, in the textile industry and in the chemical industry. In soils it is a hydrous aluminosilicate clay mineral with a layer–lattice structure (two sheets of tetrahedral silicon crystals

enclosing a sheet of octahedral aluminium crystals) that expands when water enters between layers, thus making a soil material, typically with variable water content, subject to swelling and contraction. *See also* clay minerals.

Montpellier school of phytosociology *See* Zurich–Montpellier school of phytosociology; and phytosociology; *compare* Uppsala school of phytosociology.

mooneye (*Hiodon tergisus*) *See* Hiodontidae.

moonfish 1 (opah, *Lampris guttatus*) *See* Lampridae. 2 (*Mene maculata*) *See* Menidae. 3 *See* Monodactylidae.

moon moths *See* Saturniidae.

moon rat *See* Erinaceoidea.

moor Acidic area, usually with peat development, and most typically dominated by low-growing ericaceous shrubs, though including grass and sedge-dominated areas. In many respects the terms 'moor' and 'heath' are interchangeable. A. G. Tansley (1939) maintained a traditional distinction between upland and lowland heaths, as opposed to heather moors which have deeper peat development rather than any distinctive floral characteristics. *Compare* heathland.

moorhens *See Gallinula*.

moose (elk, *Alces alces*) *See* Cervidae.

moot *See* coppice stump.

mor Type of surface humus horizon that is acid in reaction, lacking in microbial activity except that of fungi, and composed of several layers of organic matter in different degrees of decomposition.

morabine grasshopper *See* Eumastacidae.

Moraceae Family of trees and shrubs (except the herb *Dorstenia*) which produce milky latex. The leaves are simple and spiral, with stipules. The flowers are unisexual, regular, small, and grouped, often on the enlarged receptacle. The fruits are often in infructescences with a fleshy receptacle or fleshy flower parts, and many are edible. There are 75 genera, with 3000 species, occurring mainly in the tropics and subtropics.

moraine Term originally applied to the ridges of rock debris around Alpine glaciers. Subsequently its meaning has been widened to include the rock debris. For example, 'ground' moraine may denote an irregularly undulating surface of till, glacial drift, or boulder clay; or it may describe the deposit itself. An 'end' or 'terminal' moraine is a ridge of glacially deposited material laid down at the leading edge of an active glacier. Its height is in the range 1–100 m, and it is accumulated by a combination of glacial dumping and pushing. A 'recessional' moraine is a variety of terminal moraine laid down at the terminus of a glacier during a period of still-stand that interrupts a long period of ice retreat. A 'lateral' moraine is a ridge of debris at the margin of a valley glacier and largely derived from rock fall. It is a prominent feature of many contemporary Alpine glaciers. A 'medial' moraine results from the merging of lateral moraines when two glaciers converge. A 'washboard' moraine is a single ridge in a closely spaced pattern (perhaps 9–12 per kilometre) and stands some 1–3 m above the adjacent depressions. It is found in the 'end' moraine belt. A 'push' moraine is a morainic ridge made of unconsolidated rock debris and pushed up by the snout of an advancing glacier.

moray eels *See* Muraenidae.

morbidity 1 The proportion of individuals in a population suffering from a particular disease. 2 The state or condition of being diseased.

morbilli *See* measles.

Morchella (order Pezizales) Genus of fungi in which the fruiting body is several centimetres tall and consists of an ovoid head, extensively pitted with broad, shallow depressions (in line with the hymenium), borne on a whitish hollow stalk. *M. esculenta* (morel) is a highly esteemed edible species, found growing on the ground in sandy soils in woods, on banks, etc.; it is seldom abundant in Britain.

morel (common morel) Common name for the edible fruiting body of the ascomycete *Morchella esculenta*. *See Morchella*.

Moreton Bay chestnut (*Castanospermum australe*) *See Castanospermum*.

morganite *See* beryl.

Morganucodon Small, mouse-sized mammal from the Late Triassic to Early Jurassic of Europe and Asia. Known mostly from its teeth, its rather reptile-like braincase, and its lower jaw.

Moridae (morid cod; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Family of marine fish which have a fairly elongate body, and sometimes a wide head and chin barbel. Although the first dorsal fin is short, the second dorsal and anal fins are long, but may be subdivided into sections. The first few pelvic fin rays are prolonged. The Moridae are related to the Gadidae (true cods): some species are found in deep water, others may come closer inshore. *Lotella callarias* (beardie), 51 cm, and other species of S. Australia are used occasionally as food fish. There are about 70 species, found worldwide in temperate waters.

morid cod *See* Moridae.

Morinda (family Rubiaceae) Genus of small tropical trees. The flowers occur in heads, the fruits in a fleshy syncarp. Several are useful for dyeing. There are about 40 species, occurring in the tropics.

Moringa (family Moringaceae) Genus of plants which includes *M. oleifera* (horseradish tree), widely cultivated in tropical Asia for its edible, pungent, young leaves and pods (rich in vitamin C), and for ben oil, extracted from the ripe seeds. There are 10 species.

Moringaceae Small family of small trees whose leaves are 2–4 times pinnate. The flowers are bilaterally symmetrical, and pentamerous, the sepals fused, the petals free. The fruit is a long pod splitting into three valves, and the seeds are large and three-winged. There is one genus, occurring in

tropical Africa, Madagascar, and from Arabia to India.

Moringuidae (worm eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of eel-like marine fish which have a very elongate, cylindrical body. The mouth and eyes are rather small, and the pectoral fins minute. The low dorsal and anal fins are near the tail and confluent with the tail-fin. There are about 10 species, found in the Indo-Pacific region and the W. Atlantic.

Mormoopidae (ghost-faced bats, moustached bats, chin-leafed bats; order Chiroptera, suborder Microchiroptera) Family of insectivorous bats in which there is no nose leaf, but the nostrils form part of a fleshy pad extending on to both lips and, in *Mormoops* species, continuing in foliar outgrowths on the chin. The ears cover the sides of the head to below the eyes, and the tail emerges dorsally from the uropatagium. There are two genera, *Mormoops* and *Pteronotus*, with about eight species, distributed through tropical C. and S. America.

Mormyridae (elephant fish; class Osteichthyes, subclass Actinopterygii, order Mormyriformes) Fairly large family of freshwater fish, characterized in most species by the presence of an elongate, trunk-like snout. The eyes and mouth are small and the tail-fin is forked; the size of the dorsal and anal fins is variable. Several species possess electric organs capable of emitting series of low-voltage discharges, perhaps as a means of finding the way in darkness, since mormyrids are basically nocturnal. The large *Mormyrus deliciosus* (1.5 m) is used as a food fish. Other species, e.g. *Gnathonemus petersii* (22 cm) are kept occasionally as aquarium fish. There are about 100 species, found in tropical Africa.

Mormyriformes Order of primarily nocturnal freshwater fish with small eyes and mouth and varying body profile. Several genera (e.g. *Mormyrus* and *Gymnarchus*) have electric organs capable of producing weak electric discharges.

Morone saxitilis (striped bass) *See* Percichthyidae.

morpho butterflies *See* Satyrinae.

morphogenetic region Area that is characterized by a distinctive assemblage of land-forms and that coincides with a major climatic zone. It is believed that the land-forms largely result from the action of a unique combination of surface processes controlled by climate.

morphology Form and structure of individual organisms. *Compare* physiognomy.

morphospecies Group of biological organisms that differs in some morphological respect from all other groups.

Mortierellaceae (order Mucorales) Family of fungi in which the sporangia lack a columella. There are four genera, with many species, found in soil, dung, plant or animal matter, etc.

Morus **1** (family Moraceae) Genus of plants whose flowers are wind-pollinated. Their infructescences (mulberries), fleshy from the swollen, juicy perianths, and borne in blackberry-like clusters, are edible. They are widely cultivated. There are 12 species, occurring widely in warm-temperate and subtropical regions. **2** *See* Sulidae.

morwong *See* Cheilodactylidae.

mosaic General term for a virus disease of plants in which the symptoms include the appearance of angular areas of yellow colour on the leaves, forming a mosaic-like pattern.

mosaic evolution Differential rates of development of various adaptive attributes within the same evolutionary lineage. For example, a particular taxon might show greatly different rates of change with respect to the head, body, and limbs. This is a common phenomenon and makes the reconstruction of transitional fossil types very difficult.

moschatel (*Adoxa*) *See* Adoxaceae.

Moschus (musk deer) *See* Cervidae; and Palaeomerycidae.

mosquito **1** *See* Culicidae. **2** (yellow fever mosquito) *See Aëdes aegypti*.

mosquitofish (*Gambusia affinis*) *See* Poeciliidae.

moss Common name for a plant belonging to the class Musci.

moss-animals *See* Bryozoa.

mossy forest Tropical montane forest, typically with contorted trees no more than 10–15 m high, their trunks, boughs, and twigs being festooned with mosses, lichens, and liverworts. The growths of 'moss' are particularly luxuriant where mists prevail.

Motacilla (wagtails; family Motacillidae) Genus of black and white, grey, green, and yellow birds which habitually wag their long tails. *M. flava* (yellow wagtail) exists in many subspecific forms, each having a different head colour. There are 10 species, most migratory, found in Europe, Africa, Asia, Indonesia, and Alaska.

Motacilla flava (yellow wagtail) *See Motacilla*.

Motacillidae (wagtails, pipits; order Passeriformes) Family of medium-sized to small, black, grey, yellow, and brown birds, some of which are streaked. The bill is thin and slender, and the legs fairly long, with long hind claws. Motacillidae have long bodies; and long tails, usually edged with white or buff, which most species wag up and down. They inhabit grassland and open country, often near water. They feed mainly on insects, and nest on the ground. There are five genera, with 54 species, many migratory, and found worldwide.

mother cloud Incipient cloud from which a well-defined cloud type can form and develop. *See also* cloud classification.

mother-in-law's tongue (*Sansevieria trifasciata*) *See Sansevieria*.

mother-of-pearl clouds *See* nacreous clouds.

moth fly *See* Psychodoidae.

moths *See* Lepidoptera.

motile Capable of independent locomotion.

motivation The cause for a spontaneous change in the behaviour of an animal that occurs independently of any outside stimulus, or of a change in the threshold of responsiveness of an animal to a stimulus, and that is not due to fatigue, learning, or the maturation of the animal.

motivational conflict Simultaneous existence of two or more motivations that lead to contradictory patterns of behaviour (e.g. to approach a human offering food in order to obtain the food, and to flee from the human).

motmots *See* Coraciiformes; and Momotidae.

Motomura's geometric series Numerical and graphical description of the relationship of species in a community according to their importance values. Curves approximating to a geometric series are common in pioneer or ephemeral communities. In theory, the more successful species restrict other species to the remaining niche space (the preemption hypothesis) by occupying a larger proportion of the available niches. If the most successful species occupies 75% of the available niche spaces, and the next species a similar proportion of the remaining spaces, and so on, then a geometric progression of importance values will result.

mottle General term for a virus disease of plants in which the symptoms include the appearance of rounded or diffuse areas of yellow colour on the leaves.

mottling Patchwork of different colours in mineral soil (usually orange or rust against a background of grey or blue) which indicates periods of anaerobic conditions.

mould (mold) **1** Any fungus. **2** Any fungus of 'mouldy' appearance, i.e. one with abundant, visible, woolly mycelium upon which dusty or powdery conidia can be seen (e.g. *Penicillium* species).

moulting Periodic, often seasonal, shedding of hair or feathers by animals. In birds, it is the process by which feathers are periodically renewed, at least once a year, sometimes twice or (rarely) three times. Feather shedding is usually a gradual process and does not affect flight or other functions but Anatidae lose their flight feathers simultaneously, becoming temporarily flightless. The usual sequence of moult begins with the loss of primaries, followed by secondaries, tail feathers, and then body feathers. *See also* ecdysis.

mountain ash (*Sorbus aucuparia*) *See Sorbus*.

mountain beaver *See* Aplodontidae.

mountain breeze *See* mountain wind.

mountain lion (*Puma concolor*) *See Puma*.

mountain wind (mountain breeze) Term commonly used to describe a katabatic wind or breeze and its counterpart, the upslope anabatic wind or breeze occurring on warm days over heated mountain slopes.

mouse 1 (Old World) *See* Muridae. **2** (New World) *See* Cricetidae.

mousebird *See* Coliidae; and Coliiformes.

mouse lemur (*Microcebus*) *See* Cheirogaleidae.

mouse hare (*Ochotona*) *See* Ochotonidae.

mouse-tailed bat (*Rhinopoma*) *See* Rhinopomatidae.

moustached bats *See* Mormoopidae.

Mousterian culture *See Homo sapiens neanderthalensis*.

mouth-breeding fish *See* buccal incubation.

mouth-breeding frog *See Rhinoderma darwinii*.

mouth brooding *See* buccal incubation.

mRNA *See* messenger-RNA.

MSY *See* maximum sustained yield.

mucin A mucoprotein secreted by mucous cells.

muck 1 Highly decomposed organic matter in which original plant material cannot be recognized. 2 Farmyard manure (FYM) composed of animal faeces and urine mixed with straw and highly decomposed.

mucoprotein Class of mucopolysaccharides in which large numbers of disaccharide units are bound to a protein chain.

Mucor (family Mucoraceae) Genus of fungi in which colourless, branched or unbranched sporangiophores arise from the substrate mycelium and bear at their tips spherical sporangia containing many spores. Zygospores are brown to black with warty surfaces. Species are common on soil, dung, fruit, vegetables, etc. and distribution is cosmopolitan. They may cause spoilage of bread, fruit, and other foods.

Mucoraceae (order Mucorales) Family of fungi in which the sporangia typically are all alike: spherical or pear-shaped, columellate, thin-walled, and containing numerous spores. There are 20 genera, with many species, most of which are saprotrophic in soil, dung, organic debris, etc. Some can parasitize plants and some can cause disease in animals and humans.

Mucorales (class Zygomycetes) Order of fungi in which the vegetative stage typically is an extensive, usually coenocytic, eucarpic mycelium. Aplanospores are dispersed by wind, rain, insects, etc. There are 14 families. Most are terrestrial saprotrophs common in soil, dung, plant debris, etc. Some are parasitic, e.g. on other fungi.

mucro (pl. mucrones) Terminal portion of the springing organ (furcula) of Collembola, which is in contact with the substrate when the animal jumps. The furcula comprises a single basal portion, the manubrium, which gives rise to two dens, which terminate in lamellate mucrones.

Mucuna (family Leguminosae, subfamily Papilionatae) Genus of climbers, most of which have showy flowers in long racemes. Several have pods with irritant hairs. *M. bennettii* (and others with red flowers) are the New Guinea creepers, extensively planted as ornamentals. There are 120 species, occurring in the tropics and subtropics.

mucus Secretion of mucous cells and glands located in epithelial structures. It is composed largely of a mixture of mucin and water.

mud crabs *See Pseudocarcinus gigas*; and Xanthidae.

mud-flat Area of a coastline where fine-grained silt or sediment and clay is accumulating. Its development is favoured by ample sediment, by sheltered conditions, and by the trapping effect of vegetation. It is an early stage in the development of a salt-marsh.

mudflow 1 Heavily loaded ephemeral stream whose viscosity increases with evaporation as it flows over a desert fan. 2 Rapidly moving variety of earthflow. This is a typical phenomenon of areas underlain by sensitive clays which may liquefy and flow following a shock, perhaps initiated by sliding.

mud minnow *See* Umbridae.

mudnest builders *See* Grallinidae.

mudpuppy *See Necturus maculosus*.

mudstars *See* Cribellina.

mudstone Argillaceous or clay-bearing sedimentary rock which is non-plastic and has a massive or non-foliated appearance.

mud turtles *See* Kinosternidae.

Muehlenbeckia (family Polygonaceae) Genus of climbing or woody plants with simple alternate leaves and a sheathing membrane that unites the stipules. The flowers are small, and white, pinkish, or green; they are held in a raceme or solitary. There are no petals but the sepals are often enlarged. The fruit is a triangular nut and the seeds have a large endosperm. The plants are either dioecious or polygamous. There are about 20 species. The genus is centred in Australia, extending to S. America and New Zealand. Several species are cultivated as ornamentals.

mugearite *See* andesite.

Mugil cephalus (common mullet) *See* Mugilidae.

Mugilidae (grey mullet; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine and brackish-water fish, which occasionally enter rivers. Mullets have a fairly thick, solid body with rather large scales, the mouth bearing rows of fine teeth. The pelvic fins are located between the pectoral and first dorsal fins. The two widely separated dorsal fins are characteristic. Often congregating in large schools, most species feed on plankton, algae, or detritus. They are very tolerant of low salinity: some species, including *Myxus* (*Trachystoma*) *petardi* (freshwater mullet) of E. Australia, are freshwater inhabitants. *Mugil cephalus* (striped, or common mullet), 65 cm, is an example of the commercially important food fish in the family. There are about 70 species, distributed worldwide in tropical and temperate waters.

Mugiloididae (Parapercidae, sand perch, grubfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have an elongate body, small scales, a protractile mouth, and a large head. The dorsal and anal fins are long; the pelvic fins are located beneath the pectoral fins. The dorsal position of the eyes suggests a bottom-dwelling way of life. One of the larger species is *Parapercis colias* (blue cod), 65 cm, which is a popular food fish in New Zealand. Generally they are inshore fish. There are about 25 species, confined to the southern hemisphere.

mugworts *See Artemisia*.

mulberry *See Morus*.

mulch Loose surface soil horizon, either natural or man-made, composed of organic or mineral materials. It protects soil and plant roots from the impact of rain, temperature change, or evaporation.

mule killer *See Dasymutilla occidentalis*.

mull Type of surface humus horizon that is chemically neutral or alkaline in reaction, that is well aerated, and that provides generally favourable conditions for the decomposition of organic matter. Mull humus is well decomposed and intimately mixed with mineral matter.

Müllerian mimicry The similarity in appearance of one species of animal to that of another, where both are distasteful to predators. Both gain from having the same warning coloration, since predators learn to avoid both species after tasting either one or the other. The phenomenon is named after H. J. Müller who described it in relation to insects in S. America. *Compare* Batesian mimicry.

mullet *See* Mugilidae; and Mullidae.

Mullidae (goatfish, red mullet; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have an elongate body, tapering towards the tail, but a flat belly. They have a steep forehead and, characteristically, a pair of chin barbels which are probably used as feelers. They are bottom-living fish, often with distinctive colour patterns. *Mullus surmuletus* (red mullet), 40 cm, of the E. Atlantic has been a popular food fish at least since Roman times. There are about 55 species, mainly marine, distributed worldwide in warmer water.

mullite *See* aluminosilicates.

Mullus surmuletus (red mullet) *See* Mullidae.

multifactorial (polygenic) In genetics, a hypothesis to explain quantitative variation by assuming the interaction of a great number of genes (polygenes), each with a small additive effect on the character.

multilocular *See* Cynipidae.

multiple allelism Existence of several known allelic forms of a gene. *See* allele.

multiple land-use strategy Designed use of an area so that a range of compatible uses, or activities that can be rendered compatible by careful management, may be practised in a single locality—for example, forestry with rambling, camping, nature conservation, flood control, etc.

multiseriate Arranged in many rows.

Multituberculata (class Mammalia, subclass Prototheria) Extinct order of rather rodent-like mammals, which appeared first in the late Jurassic in Europe, flourished during the Cretaceous and Palaeocene, but became extinct during the Eocene. Probably they were the first herbivorous mammals, with skull and teeth analogous to those of rodents. Most were small, but some attained the size of modern woodchucks. The limbs sprawled more widely than those of most mammals. The olfactory bulbs were large, which suggests that the animals depended heavily on their sense of smell. The skull was massive, but unlike that of other mammalian groups. The multituberculates appear to have been a side branch from the main line of mammalian evolution, and they are believed not to be related closely to other groups.

mumps Acute, infectious disease which affects mainly children; some other primates are also susceptible. Symptoms include fever with swelling and inflammation of the salivary glands. It is caused by a paramyoxovirus.

munias *See Amandava*; Estrildidae; and *Lonchura*.

Munsell colour Soil-colour system, devised originally in the USA, that is based on the three variables of colour—hue, value, and chroma—and given notation such as '10YR 6/4'. It is now used as an international method for reporting soil colour.

Muntiacus (muntjac) *See* Cervidae.

muntjac (*Muntiacus*) *See* Cervidae.

Muraena helena (Greek moray) *See* Muraenidae.

Muraenesocidae (pike conger; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of marine eel-like fish which have a cylindrical body, scaleless skin, narrow head with large eyes, strong teeth, and the dorsal fin starting above the well-developed pectoral fins. Some species are known to enter brackish water. These rather aggressive fish are found throughout the world in tropical to subtropical seas, and some are quite large (e.g. *Muraenesox arabicus*, 2 m). There are about seven species.

Muraenidae (moray eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Large family of marine, eel-like fish which have a slightly compressed, scaleless body; they have well-developed dorsal and anal fins, but the pectoral and pelvic fins are absent. Many species exhibit colourful markings in the skin. Usually found in cracks and crevices between rocks near the sea-bottom, they can be very aggressive when handled. *Muraena helena* (Greek moray), 1.1 m, was a food fish well known to the Romans. Some species are very large, e.g. *Thyrsoidea macrura* (longtailed reef-eel), 4.1 m, of N. Australia. There are about 100 species, distributed worldwide in tropical to temperate waters.

Muridae (order Rodentia, suborder Myomorpha) Family of Old World rats and mice, perhaps the most successful of all mammalian families. They are small terrestrial, arboreal, burrowing or semi-aquatic animals. The tail is long and scaly; the limbs are pentadactyl, the first digit of the forelimb being rudimentary. In some saltorial forms the hind limbs are modified. *Apodemus sylvaticus* is the European field mouse. *Mus musculus* is the house mouse, which originated in the drier areas of Eurasia but has spread throughout the world. The Muridae appeared first during the Oligocene and radiated explosively during the Pliocene. They reached Australasia (including New Guinea and the Solomon Islands) before the first humans, and radiated there into some 28 genera, including *Notomys* (jerboa-rat) which resembles the true jerboas (family Dipodidae). There are at least 220 genera, with more than 1000 species.

muriform Resembling a brick wall; having both transverse and longitudinal cross-walls.

murine Of or like a mouse; mouse-coloured.

murine typhus Disease which affects mainly rats. The causal agent is *Rickettsia mooseri*, which is transmitted by fleas. Humans can be infected; the disease resembles classical typhus but generally is less severe.

Murraya (family Rutaceae) Genus of trees and shrubs containing essential oils, in which the leaves are pinnate, and the fruit a berry. Leaves of *M. koenigii* are used in India to flavour curries. There are 12 species, occurring from E. Asia to the Pacific islands.

Murray cod (*Maccullochella peeli*) *See* Percichthyidae.

Musa (family Musaceae) Genus of giant, rhizomatous herbs which have an erect pseudostem formed from overlapping leaf bases, and terminal inflorescences. The flowers are unisexual, the males terminal and subtended by coloured bracts. The fruit is an elongate berry with many stony seeds (absent in the edible bananas). *Musa* are bat-pollinated. Cultivated bananas are hybrids, and triploid or tetraploid. There are 35 species, occurring in the palaeotropics. *See* abacá.

Musaceae Family of giant herbs whose leaves have a midrib and parallel secondary nerves at right angles, often becoming tattered. There are two genera, occurring in the Old World tropics.

Musanga (family Urticaceae) Genus of one species, *M. cecropioides*, a soft-stemmed, fast-growing, pioneer tree of humid tropical Africa.

Musa textilis *See* abacá.

Musci (mosses; division Bryophyta) Class of plants all of which have a gametophyte that is differentiated into stem and leaves. The leaves are generally only one cell thick (except at the midrib); they are never stalked. The leaves may be finely toothed or entire; they come in a variety of shapes but are never deeply lobed, differing in this respect from some leafy liverworts. Most mosses are either acrocarpous or pleurocarpous. Mosses can be found in a wide range of habitats, growing on rocks, soil, tree bark, etc. Their distribution is cosmopolitan.

Muscicapa (flycatchers; family Muscicapidae) Genus of slate-grey to brown flycatchers which have plain or streaked under-parts. They are arboreal, catching insects in the air, and nest in trees and

bushes. *M. striata* (spotted flycatcher) sometimes uses nestboxes. There are 22 species, most of which are migratory, found in Europe, Africa, and Asia.

Muscicapidae (Old World flycatchers, fantail, whistlers; order Passeriformes) Diverse, often highly coloured family of birds, some of which have crests or wattles. The bill is narrow to broad, with rictal bristles; the wings are short and rounded to long and pointed; the tail is usually short to medium; and the legs are short. Muscicapidae are mainly arboreal, and feed on insects caught in the air or on the ground. The nest is usually cup-shaped and made in a tree or bush, or in a hole in a tree or bank. There are about 60 genera, with about 350 species, most of which are migratory, found in Europe, Africa, Asia, and Australasia. Maluridae and Epthianuridae are sometimes included in this family.

muscicolous Growing on or among mosses.

Muscidae (houseflies; class Insecta, order Diptera, suborder Cyclorrapha) Family of small to large flies, all of similar appearance, most of which can be distinguished from the similar Tachinidae and Calliphoridae families by their lack of hypopleural bristles. The wing veins Cu_1 +1A do not reach the margin of the wing. The lower calypter of the wing is nearly always longer than the upper one. *Musca domestica* is typical of the family. The female fly selects faeces or other organic refuse as a medium on which eggs are laid in masses of 100–150. The larvae feed on the substrate and pupate after eight days at 30 °C. The speed of development and potential for increase make the housefly a formidable pest. The adult fly is a well-documented carrier of many human-disease organisms because of its preferred habitat and its association with human dwellings. The destruction of breeding sites and the fly-proofing of premises are the best means of control. Other species include several that are haematophagous, e.g. of the genus *Stomoxys* (stable flies). More than 3800 species occur throughout the world. *See also* venation.

muscovite Mineral, specific gravity 2.8–2.9, hardness 2.5–3.0, and with the chemical composition $KAl_2(AlSi_3O_{10})(OHF)_2$, whose name is derived from the old Italian word for 'Moscow'. It is widely distributed, being found in igneous alkali granites, in pegmatites, and also as a secondary mineral resulting from the decomposition of feldspars. It can also be a major constituent of clastic sediments, e.g. sandstone and silts. It is distinguished by its perfect cleavage and very light colour. It is normally colourless to very pale grey to green or light brown, and has a vitreous to pearly lustre. It crystallizes in the monoclinic system. The crystals are tabular, hexagonal, and also occur in foliated masses and disseminated flakes. It is a rock-forming mineral.

musculoepithelial *See* myoepithelial.

museum beetle (*Anthrenus*) *See* Dermestidae.

mushroom *Agaricus bisporus* (the cultivated mushroom) or any edible fungus similar to it in appearance.

Musiphagiformes *See* Musophagidae.

musk beetle (*Aromia moschata*) *See* Cerambycidae.

musk deer (*Moschus*) *See* Cervidae; and Palaeomerycidae.

muskeg Ill-drained, often extensive, boggy tract, with at best sparse, stunted trees, which occurs within the boreal forest. The vegetation is dominated by *Sphagnum* species (bog moss) and *Eriophorum* species (cotton sedge).

muskellunge (*Esox masquinongy*) *See* Esocidae.

musk-ox (*Ovibos moschatus*) *See* Bovidae.

musk rat (musquash, *Ondatra zibethicus*) *See* Cricetidae.

musk turtles *See* Kinosternidae.

Mus musculus (house mouse) *See* Muridae.

Musophagidae (touracos, go-away birds, plantain-eaters; order Cuculiformes) Family of medium to large birds, some of which are brightly coloured with green, purple, and red, others a duller grey or brown. They have crested heads, bare skin around the eyes, and short, stout bills. Their wings are short and rounded, and their tails long. The red pigments are copper-based and, together with the green pigments, are unique to touracos. They inhabit forests and bush, feed on fruit and berries, and nest in trees. There are five genera, with 18 species, often placed in their own order, Musiphagiformes. They are found in Africa.

musquash (musk rat, *Ondatra zibethicus*) *See* Cricetidae.

Mussaenda (family Rubiaceae) Genus of small trees and shrubs in which the flowers have one sepal enlarged, leafy, and brightly coloured, rendering the inflorescence showy and conspicuous. Several species are ornamentals. There are 200 species, occurring in the palaeotropics.

mussel shrimps *See* Ostracoda.

Mustela (mink, stoat, weasel) *See* Mustelidae.

Mustelidae (weasels; order Carnivora, suborder Fissipedia, superfamily Canoidea) Family of carnivores characteristic of northern temperate latitudes, where they occupy niches similar to those occupied by the Viverridae of lower latitudes. They are relatively primitive, with short, stocky legs. They have long, sharp canine teeth and well-developed carnassials, but, in modern forms, never more than one post-carnassial molar in each jaw. Most are small, but a Miocene American mustelid, *Megalictis*, was the size of a black bear. They had diverged from their miacid ancestors by the Eocene–Oligocene transition and later branched widely, one line giving rise to the seals (Phocidae). The largest modern mustelid is *Gulo gulo* (wolverine, glutton, carcajou, or skunk bear) of Arctic regions, which grows to more than 1 m in length and a weight of more than 18 kg. Some (e.g. *Meles* and *Taxidea*, the Old and New World badgers, and *Mephitis*, the skunks) have adapted to an omnivorous diet, as has *Mellivora capensis* (honey badger or ratel) of Asia. The family also includes the martens, e.g. *Martes martes* (pine marten of Eurasia)

and *Mustela* (mink). Otters (e.g. *Lutra*) have adapted to a semi-aquatic way of life and a diet consisting mainly of fish, with *Enhydra* becoming wholly marine. Mustelids are distributed throughout the world, except for Madagascar and Australasia. There are about 25 living genera, with about 70 species.

Mustelus mustelus (dogfish, smooth hound) *See* Carcharhinidae.

musth In sexually mature male elephants, a physiological and behavioural condition associated with sexual activity. It lasts 2–3 months, during which testosterone levels are high; the temporal glands become enlarged and temporin secretion becomes copious; urine is discharged continally, and behaviour becomes more aggressive. Musth occurs annually or biennially, but at any time of year rather than within a particular season. Its occurrence is not synchronized among groups of males.

mutagen Agent that increases the mutation rate within an organism. Examples of mutagens are X-rays, gamma rays, neutrons, and certain chemicals such as carcinogens.

mutagenic Causing a mutation.

mutant 1 Cell or organism that carries a gene mutation. 2 Gene that has undergone mutation.

mutation 1 Process by which a gene or chromosome set undergoes a structural change. 2 Gene or chromosome set that has undergone a structural change. The majority of mutations are changes within individual genes (e.g. the substitution of a different nucleotide at some point in the DNA so that the amino-acid sequence is altered), but some are gross structural changes of chromosomes (for example inversion or translocation) or changes in the number of chromosomes per nucleus (e.g. polyploidy). Mutations are the raw material for evolution: they provide the source of all variation. For mutations to affect subsequent generations, though, they must occur in gametes or in cells destined to be gametes, since only then will they be inherited. A mutation that occurs in a body-cell is called a 'somatic mutation': it is transmitted to all cells derived, by mitosis, from that cell. Most mutations, however, are deleterious; evolution progresses through the few that are favourable. Some mutations are recurrent—they occur repeatedly within a population, or over long periods of time (as does haemophilia, for example).

mutation rate Number of mutation events per gene per unit of time (e.g. per cell generation). The term is also applied to the frequency with which mutation events occur in a given species or to the frequency with which a specified mutation event or mutational class occurs in a given population. Normally mutations occur at a constant, very low, rate: this rate can be greatly increased by irradiation with X-rays, gamma rays, neutrons, etc., or by treatment with carcinogens.

mutatus Form of cloud evolution in which the mother cloud is greatly affected by the development of cloud from it.

mute swan (*Cygnus olor*) *See Cygnus*.

Mutica (class Mammalia, infraclass Eutheria) Cohort comprising the single order Cetacea, the whales. They are believed to have evolved from carnivorous or pre-carnivorous mammals which fed on fish. Ancestral whales flourished during the Eocene, by which time many structural adaptations had occurred.

Mutillidae (velvet ants; suborder Apocrita, superfamily Scolioidea) Family of wasps which are parasitic on ground-nesting sphecoid and vespoid wasps and solitary bees. Adults are hairy and often brightly coloured, the males being winged and the females apterous. The apterous females resemble ants but have a 'felt line' on the second gastral segment, and can inflict painful stings. *Mutilla europaea* is 12 mm long (others are 6–20 mm), with a reddish thorax, and a dark blue abdomen with pale, velvety hairs: it is a parasite in bumble-bee nests.

Mutinus (order Phallales) Genus of fungi which form fruit bodies resembling those of *Phallus* species. In *Mutinus caninus* ('dog stinkhorn') the fruit body has a pink or orange tinge, and the cap is initially covered with a dark green slime containing the spores. The odour is faintly foetid, but less so than in *Phallus impudicus*. *Mutinus* are found on the ground in woods, and are widespread.

mutual inhibition Interaction of species populations in which both species actively inhibit one another.

mutualism Interaction of species populations that benefits both populations. Strictly, the term may be confined to obligatory mutualism, in which neither species can survive under natural conditions without the other. Sometimes the term is used more generally to include facultative mutualism (protocooperation).

Mycelia Sterilia Category of fungi in which there is apparently no reproductive structure of any kind.

mycelium Mass of hyphae, which makes up the vegetative stage of many fungi and actinomycetes.

Mycena (family Tricholomataceae) Genus of fungi in which the fruit bodies are small and delicate, with a conical or bell-shaped cap and a long, slender, central stipe. Spores are smooth and colourless. There are many species, found on the ground, on wood, on plant debris, etc.

mycetocyte In certain types of insect, a cell that contains symbiotic fungi or bacteria.

mycetome Special organ comprising a group of specialized gut or fat cells, containing symbiotic micro-organisms, e.g. as in the gut of many Coleoptera, Homoptera, and other insects. Gut mycetomes appear to develop from detached intestinal crypts containing symbiotic yeasts or bacteria, and they are believed to play a part in the metabolism of vitamins and other essential substances.

Mycetophagidae (fungus beetles; class Insecta, order Coleoptera) Family of tiny, oval, pubescent

beetles, 1.5–3 mm long, with inconspicuous coloration. The head is triangular, the antennae clubbed. The eyes are many-faceted, giving a rough appearance. Larvae are tawny, subcylindrical, with well-developed legs. Adults and larvae are found in fungi and rotting material. *Typhaea stercorea* commonly occurs in compost heaps and in stored products affected by mould. There are 200 species, with worldwide distribution.

Mycetophilidae (fungus gnats; class Insecta, order Diptera, suborder Nematocera) Family of small flies which have long antennae, and ocelli. The tibiae have spurs, and the coxae are elongate. The thorax is more or less arched, often strikingly so. The common name refers to the usual feeding substrate of the larvae, which often live gregariously among decaying vegetable matter or in fungi. The larvae are usually pale in colour, and have a hard, sclerotized head, and 12 segments. Several species are economically important as pests of mushrooms, but others attack only wild fungi. Several species are luminous, the light being emitted from the distal part of the Malpighian tubules. Although they are similar in many respects to the Mycetophilidae, the Sciaridae (Sciarinae) are now regarded as a separate family. There are more than 2000 described species, with a worldwide distribution.

mycetozoans Slime moulds and related organisms.

Mycobacteriaceae (order Actinomycetales) Family of aerobic, Gram-positive bacteria, which form branched or unbranched, straight or curved rods, or fragile filaments. Spores are not formed. There is one genus, *Mycobacterium*.

Mycobacterium (family Mycobacteriaceae, order Actinomycetales) Genus of bacteria (characteristics as for the family) which includes many species, among which are several important pathogens. *M. tuberculosis* (the tubercle bacillus) causes tuberculosis in humans, other primates, dogs, and certain other animals. *M. bovis* (bovine tubercle bacillus) also causes tuberculosis, and is generally more pathogenic in cattle and various other animals than is *M. tuberculosis*. *M. avium* (avian tubercle bacillus) causes tuberculosis in birds, including domestic fowl. *M. leprae* causes leprosy in man. The genus also includes some saprotrophic species. *M. phlei* (timothy-grass bacillus) is non-pathogenic and is found on grass and hay.

mycobiont The fungal symbiont in a lichen.

mycocecidium Gall formed on a plant as a result of infection by a fungus.

mycology The study of fungi.

Mycoplasma *See* Mycoplasmataceae.

mycoplasmas *See* Mollicutes.

Mycoplasmataceae (class Mollicutes) Family of Gram-negative prokaryotic organisms, which require the presence of sterols for growth. Cells are pleomorphic, ranging from spherical to filamentous. They are chemo-organotrophic. There is one genus, *Mycoplasma*, and many species, found as parasites and pathogens in a variety of mammals and birds. Some species can cause a type of pneumonia in humans and other animals.

Mycoplasmatales *See* Mollicutes.

mycorrhiza Close physical association between a fungus and the roots of a plant, from which both fungus and plant appear to benefit; a mycorrhizal root takes up nutrients more efficiently than does an uninfected root. A very wide range of plants can form mycorrhizas of one form or another, and some plants (e.g. some orchids and some species of *Pinus*) appear incapable of normal development in the *absence* of their mycorrhizal fungi.

mycosis Any disease of humans or other animals in which the causal agent is a fungus.

mycotoxin A toxin produced by a fungus.

mycotrophic Applied to a plant that is associated with a fungus in a mycorrhiza.

mycovirus Virus that infects and replicates in fungi.

Myctophidae (lanternfish; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Large family of marine, mainly deep-water, fish, which have a slender and compressed body, a single dorsal and adipose fin, and a distinct anal fin. The mouth and eyes are large. Generally small fish, they are probably the most abundant deep-sea fish, occurring in schools at depths exceeding 500 m during the day, but sometimes found near the surface at night. Like other members of the family, *Myctophus punctatus* (lanternfish), 10 cm, possesses rows of small light organs along the lower part of the body. There are about 220 species, found worldwide.

Myctophiformes Order of marine fish which have a slender body, single dorsal and often an adipose fin, and forked tail-fin. Some families (e.g. the Synodontidae) are found in coastal waters. Others, e.g. the Myctophidae and Evermanellidae, are typical deep-sea fish.

myelin Heterogeneous substance composed mainly of lipids, but also of some polysaccharides, proteins, salts, and water. It is the predominant component of the Schwann cells that form insulating sheaths around the longer nerve-cell processes of vertebrates.

Myina (class Pelecypoda, order Myoida) Suborder of pelecypods, which possess essentially the same characteristics as those of the order, except that forms with an internal resilium have an external ligament developed on prominent nymphs. The pallial line has a sinus. They first appeared in the Permian.

Myliobatidae (eagle ray; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Small family of marine rays, which have large, wing-like, pectoral fins with pointed tips. The elevated head, with its large eyes, stands clear of the disc formed by the pectorals. A small dorsal fin, but no caudal fin, is found on the whip-like tail, which is longer than the body and which may bear a venomous spine just behind the dorsal fin. Although usually feeding near the bottom of the sea, eagle rays, e.g.

Myliobatis aquila (Atlantic eagle ray), 1.8 m, are active swimmers, sometimes making spectacular jumps out of the water. There are about 15 species, distributed worldwide.

Myliobatis aquila (Atlantic eagle ray) *See* Myliobatidae.

mylonite Rock produced in zones of tectonic dislocation, e.g. fault and shear zones. Mechanical crushing and grinding or cataclasis produces a rock that has a crude foliation and a finer grain size than had its precursor.

Mymaridae (fairyflies; suborder Apocrita, superfamily Chalcidoidea) Family of Hymenoptera, which are perhaps noteworthy for being among the smallest known insects, sometimes being less than 0.25 mm long. Adults are usually blackish or black and yellow, with long, thin legs and antennae, and very narrow, hair-fringed wings. The hindwing is very narrow or nearly linear, and both fore- and hindwings have a characteristic, highly reduced venation. The ovipositor is sometimes very long and brought forward in a loop beneath the thorax. All members of the family are egg parasites of various insects. Their common name refers to their small size, delicate shape, and tiny, hair-fringed wings.

mynahs *See Acridotheres*; and Sturnidae.

Myocaster coypu (coypu) *See* Capromyidae.

myocoel Coelomic cavity which forms in that part of the mesoderm (the germ layer of triploblastic animal embryos composed of cells that have moved from the surface to the interior) that will differentiate into striated muscle.

myo-epithelial (musculo-epithelial) In hydras, applied to the most conspicuous cells of the ectoderm. They are columnar in form, with contractile processes extending into the mesogloea and broad outer bases which meet to form a continuous sheet. In some Coelenterata (e.g. jellyfish) the epithelial part of the cells may be reduced.

myofibril Bundle of contractile filaments (myofilaments), 1–2 μm in diameter, that are arranged in parallel groups in the cytoplasm of striated muscle cells.

myoglobin Haemoprotein consisting of a single polypeptide chain surrounding a haem group that is capable of reversibly binding oxygen. It has a higher affinity for oxygen than has haemoglobin and releases it only when the oxygen supply becomes limiting. Myoglobin is found in the muscles of vertebrates and certain invertebrates, where it serves to store oxygen.

Myoida (phylum Mollusca, class Pelecypoda) Order of pelecypods which are not equilateral in shape, and in which the valves may be equal or unequal. The shells are thin, and never nacreous. The dentition consists of a cardinal tooth in each valve, and some have edentulous valves. Musculature is isomyarian or anisomyarian, and there is no escutcheon or lunule. Siphons are well developed for a burrowing or boring way of life. They first appeared in the Carboniferous.

Myomorpha (cohort Glires, order Rodentia) Suborder comprising nine families of rodents, in which the median portion of the masseter runs through the infra-orbital canal and both superficial and median parts of the masseter are inserted on the face. If present, premolars are small and are shed early in life. The families in the suborder are probably not closely related, the grouping being based on superficial characteristics. The suborder includes the rats, mice, voles, hamsters, dormice, etc.

Myoporaceae (emu bushes) Family of ornamental trees and shrubs, with some timber trees. The leaves are alternate or opposite, entire or toothed, often glandular or covered with woolly, glandular, or scaly hairs. The flowers are irregular, axillary, and either solitary or in clusters. The calyx and corolla are both of five fused sepals or petals forming a five-lobed tube. The four stamens are fused to the corolla. The ovary is superior, the fruit a drupe, and the seeds have almost no endosperm. Several species are of horticultural interest. The family contains four genera, with 150 species, most of them confined to Australia, but also found in the S. Pacific and S. Africa.

Myoporum (emu bushes; family Myoporaceae) Genus of small trees and shrubs with alternate leaves and small creamy white or lavender flowers with a short corolla tube and cream, yellow, or purple drupes. *M. laetum* is a timber tree. There are 32 species found mainly in Australia, E. Asia, and New Zealand.

Myoporum laetum *See Myoporum*.

myosin The predominant protein of the myofibrils of muscle cells. It has an unusual shape for a protein, having a globular head and a rod-like tail.

Myosotis (forget-me-not; family Boraginaceae) Genus of hairy herbs with simple, alternate leaves, and curved (scorpioid) cymes of small flowers each with a five-lobed calyx. The five-lobed, wheel-shaped corolla may be pink at first, then blue. Forget-me-nots are much cultivated for their flowers. There are some 405 species, occurring in temperate regions.

Myoxocephalus scorpius (father lasher) *See* Cottidae.

Myrialepis (family Palmae) Monotypic genus of climbing palms (rattans) which are clump-forming. They are dioecious. The inflorescences are produced from the uppermost leaf axils, the stem then dying. The fruits have innumerable (myriad) tiny scales, like shark's skin. They are found in Malaya and Sumatra.

Myricaceae Family of shrubs, with alternate leaves dotted with aromatic, resinous glands. The flowers are monoecious or dioecious, and are borne in catkins: male flowers have no bracteoles and 2–16 stamens; females have bracteoles and tiny, one-celled ovaries. The fruit is a nut or a drupe. There is one genus, with 60 species, found through most of the world.

Myriophyllum (water milfoils; family Haloragidaceae, subfamily Haloragoideae, tribe Myriophyllae)

Genus of submerged freshwater aquatic herbs with a few terrestrial species. The leaves are in whorls, finely pinnate when submerged and with no stipules. The flowers are in panicles or spikes held above the water and are generally very small. The fruit is usually a small dry nut, separating into two or four one-seeded nutlets. The seed has a copious endosperm. The genus forms winter buds, which survive in the bottom of a lake or river, and from which the plant can develop in the spring. There are about 45 species, with cosmopolitan distribution.

Myristica (family Myristicaceae) Genus of monopodial trees, in which the fruit has an aril that is much divided, almost to the base. The seed of *M. fragrans* is nutmeg; its aril provides mace. There are 71 species, making this the biggest genus in the family, occurring from India to the Pacific islands.

Myristicaceae Family of plants whose bark produces a watery, blood-like exudate. The leaves are simple, alternate, and in flat sprays, without stipules. The flowers are unisexual, usually dioecious, tiny, and usually trimerous; the stamens are united as a column; the ovary is superior. The fruit is fleshy and dehiscent, with one large seed enveloped in an often divided red aril; the endosperm is ruminate. There are 16 genera, with 380 species, occurring throughout the tropics but centred in Malesia, mostly in lowland rain forest.

Myrmeciinae (bulldog ants; order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of primitive ants, which have one or two petiolar nodes, and a powerful sting. The workers are large and predatory, and usually inhabit soil nests. There are 120 species, most of which occur only in Australia.

Myrmecobiidae (order Marsupialia, superfamily Dasyuroidea) Family consisting of the single species *Myrmecobius fasciatus* (numbat or banded ant-eater). This animal has up to 52 teeth, an elongated snout and no pouch, and feeds on ants and termites. It is distributed in open forest and scrub habitats in W. and S. Australia.

Myrmecobius fasciatus (banded ant-eater, numbat) *See* Myrmecobiidae.

Myrmecodia (family Rubiaceae) Genus of epiphytic herbs in which the stem base forms a swollen, chambered, coarse tuber, inhabited by ants. There are 45 species, occurring from Malesia to the Pacific islands.

Myrmecophagidae *See* Myrmecophagoidea.

Myrmecophagoidea (ant-eaters; order Edentata, suborder Xenarthra, infra-order Pilosa) Superfamily containing the one family Myrmecophagidae. In these animals the snout is elongated, the extent of the elongation depending on the overall body size of the animal, so that it is *Myrmecophaga* (giant ant-eater) that possesses the longest snout. There are no teeth. The tongue is long and sticky, the hard palate extended to the rear by the union of the pterygoid bones. The limbs, of approximately equal length, bear four or five digits, with large claws used for digging and for defence. The tail is long. *Myrmecophaga* is terrestrial; *Cyclopes* and *Tamandua* are smaller, arboreal, and have prehensile tails. There are three genera, with four species, distributed throughout tropical C. and S. America.

myrmecophile Applied to a species which relies on ants for food or protection in order to complete its life cycle. Food is obtained from the ants by direct parasitism, predation, stealing, or scavenging.

Myrmecophilidae (ant-loving crickets; order Orthoptera, suborder Ensifera) Family of small, ovoid, wingless crickets which live in ant nests. They feed on ant secretions and appear to be accepted by the ants as colony members. Representatives of the single myrmecophilid genus are found in Europe, Asia, America, and Australia.

Myrmeliontidae (subclass Pterygota, order Neuroptera) Family of insects in which the adults resemble damselflies, but have conspicuous, clubbed antennae as long as the combined head and thorax, and are softer-bodied. Most species are large, with lightly patterned wings, and the abdomen is long and thin. The eggs are laid singly in dry soil or sand, and the larvae (ant lions) burrow into the substrate, forming a steep-sided, conical pit into which prey items fall. The larvae of some species have a very elongate prothorax, but all have large, sickle-shaped jaws for capturing their prey.

Myrmicinae (parasol ants; order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of ants in which the petiole is composed of two node-like segments. The tip of the gaster is equipped with a sting, supplied with venom from glands. The subfamily has a worldwide distribution and there are about 5000 species. *See also* fungus garden.

Myrmothera (antpittas; family Formacariidae) Genus of small antbirds which have chestnut-brown upper-parts and grey or white under-parts, streaked in one species. They have very short tails, long legs, and medium-sized, stout bills. They are terrestrial, feeding on ants, and nesting on the ground. There are two species, found in northern S. America.

myrobalans *See Terminalia*.

Myrsinaceae Family of trees and shrubs with alternate, simple, leathery leaves with no stipules and often with resin ducts or glands. The flowers are regular, small, and bisexual or if unisexual then dioecious. They are held in clusters on short shoots in the leaf axils, or in terminal cymes or panicles. There are 4–6 sepals and petals which may be united at the base forming a lobed corolla. The stamens are opposite the corolla lobes and of the same number. The ovary is superior with a few locules. The fruit is a fleshy drupe and the seed has a thick endosperm. There are two subfamilies, about 35 genera, and over 1000 species. The family is widely distributed in tropical and subtropical regions of Africa, Asia, Australia, and America.

Myrtaceae Family of mainly tropical and subtropical plants in which the leaves are simple, commonly opposite, finely dotted with oil glands, and without stipules. The flowers are regular, with

four or five petals, numerous exserted stamens, and the ovary more or less inferior. The fruit is a woody capsule or a berry. There are one to many seeds. Some are ornamentals with showy flowers. Many produce valuable timbers. There are 100 genera, comprising 3000 species, occurring especially in America and Australia.

Mystacinidae (order Chiroptera, suborder Microchiroptera) Family of omnivorous bats. They have thick fur, talons on all claws, and wings which tuck into pockets when the animals are at rest. Mystacinid bats are very active on the ground and may feed there on insects, fruit, pollen, flowers, and possibly on carrion. The ears are simple, long, and well developed. The nose is simple. There is a single genus, *Mystacina*, and one species, found only in New Zealand.

Mystacocarida (phylum Arthropoda, subphylum Crustacea) Class of crustaceans, first described in 1943, known from only three species in one genus, *Derocheilocharis*, and related to the copepods and barnacles. Mystacocarids are tiny filter feeders, 0.5 mm or less in length, and are adapted for life between intertidal sand grains. Although the elongate, cylindrical body is divided as that of the copepods, transverse constriction divides the head, and the thoracic segment bearing the maxillipeds is only incompletely fused with the head. Four of the five thoracic segments bear uniramous appendages, each reduced to a single, simple lamella. Both pairs of antennae are well developed, and the feeding appendages are setose, and longer than those of the copepods. Only a nauplius eye is present.

Mysticeti (baleen whales; cohort Mutica, order Cetacea) Suborder comprising the three families (Eschrichtiidae, Balaenidae, Balaenopteridae) of baleen whales. Teeth are absent in adults (vestigial teeth may be present in the foetus) and transverse sheets of baleen (keratin) extend like combs from the roof of the mouth into the buccal cavity: these are used to strain plankton from water. There is a pair of nasal openings.

Mytiloida (phylum Mollusca, class Pelecypoda) Order of epifaunal, byssate pelecypods which have an equivalve, but highly non-equilaterally shaped, shell with a prismatic-nacreous microstructure. They have a dysodont dentition, the ligament is parivincular and opisthodetic, and the gills are eulamellibranchiate and filibranchiate. Mytiloida have an anisomyarian musculature. The pallial line is complete, the siphons poorly developed. They first appeared in the Devonian.

myxamoeba Amoeboid cell formed by a slime mould.

Myxine glutinosa (Atlantic hagfish) *See* Myxinidae.

Myxinidae (hagfish; class Osteichthyes, subclass Actinopterygii, order Myxiniformes) Small family of marine, jawless fish (or fish-like vertebrates), which have an elongate and slender body. They have a cartilaginous skeleton; paired fins and scales are absent. The slit-like mouth is surrounded by barbels and is supported by a powerful rasping tongue. There is considerable variation in the number of round gill openings. The nearly blind *Myxine glutinosa* (Atlantic hagfish), 60 cm, usually lives partly hidden in soft, muddy sea-bottoms, preying on worms, crustacea, or dying fish. There are about 19 species, found in temperate to cold water.

Myxiniformes (class Pteraspidomorphi) Order of jawless marine fish, or fish-like vertebrates, which comprises only the family Myxinidae.

Myxobacterales Order of Gram-negative bacteria, which are capable of a gliding motility when in contact with a surface. Vegetative cells are rod-shaped, and often embedded in slime. Under suitable conditions cells aggregate to form a fruiting body containing resting cells; fruiting bodies are often brightly coloured and may be visible to the naked eye. These bacteria are aerobic chemoorganotrophs, obtaining nutrients mainly by producing enzymes that disrupt other bacteria or fungi. There are four families, with many species, found in soil, dung, and decaying plant matter.

Myxococcaceae (order Myxobacterales) Family of gliding bacteria which form spherical or oval resting cells in variously-shaped fruiting bodies. Nutrients are obtained by the enzymic disruption of cells of other bacteria. There is one genus, *Myxococcus*, which is very common in soil and dung.

Myxogastromycetidae (class Myxomycetes) Subclass of slime moulds in which spores develop within a delicate or tough membrane. Species are found on rotting wood, plant litter, dung, soil, etc.

myxomatosis Virus disease of rabbits. It is endemic in Uruguay and Brazil, where it causes an almost symptomless infection in rabbits of the genus *Sylvilagus*. The virus was introduced into some countries, e.g. Australia and Britain, as a means of biological control of the rabbit population; in rabbits of the genus *Oryctolagus* the disease involves inflammation and swelling of mucous membranes, e.g. of eyes and nose, and originally had a mortality rate of 99%. The disease now has a much lower mortality rate due to the natural selection of resistant strains of rabbit and to a loss of virulence of the virus (a poxvirus).

Myxomycetes ('true slime moulds'; division Myxomycota) In mycological classification, a class of slime moulds in which the feeding stage of the organism is a plasmodium. Under appropriate conditions the plasmodium typically forms fruiting bodies in which spores are formed. The fruiting bodies are usually visible to the naked eye and in some cases may be quite large. The organisms are widely distributed and are found on decaying wood, humus, soil, bark, dung, etc.

Myxomycota In mycological classification, a division in which are placed the slime moulds and related organisms. In these organisms the feeding stage is either a plasmodium or many separate amoeboid cells (myxamoebae). The division usually includes four classes.

Myxophyta An old name for the Cyanobacteria.

Myxosporidea (subphylum Cnidospora) Class of protozoa, which parasitize invertebrates and lower vertebrates, particularly fish, often fatally for the host. The spores contain a coiled polar filament. When a spore is ingested by a new host the filament is extruded and attaches the spore to the gut wall of the host. There are three orders.

myxoviruses Collective (non-taxonomic) term for the orthomyxoviruses and paramyxoviruses.

Myxus (*Trachystoma*) *petardi* (freshwater mullet) *See* Mugilidae.

Myzomela (honeyeater; family Meliphaigidae) Genus of brown and black birds: the males often have scarlet areas, and the females are dull brown. They inhabit forests, feed on nectar and insects, and build a cup-like nest in a tree fork or on a branch. There are 24 species, found in Indonesia, New Guinea, Australia, and many Pacific islands.

Myzopodidae (golden bat, snake-footed bat; order Chiroptera, suborder Microchiroptera) Family of bats in which the ears are large, simple, and separate, but have a near-circular process in the antitragus. The nose is simple. There are adhesive suckers on all four limbs. This bat is found only in Madagascar. There is one genus, *Myzopoda*, and one species.

N

N *See* nitrogen.

Na *See* sodium.

nacreous Applied to the appearance of the pearly inner surface of some bivalve shells (mother-of-pearl).

nacreous clouds (mother-of-pearl clouds) Type of cloud seen occasionally at great altitude (approximately 22–24 km), just before sunrise or after sunset, characterized by iridescent colouring. The cloud is fine and rather lenticular.

NAD *See* nicotinamide adenine dinucleotide.

NADP *See* nicotinamide adenine dinucleotide phosphate.

nagana Disease of domestic animals which occurs in Africa. The causal agent is a species of *Trypanosoma*. *T. brucei* infects horses and related animals and can cause a fatal disease. *T. congolense* causes a wasting disease in cattle and other animals. The parasites are transmitted by tsetse flies (*Glossina* species).

Najadaceae Family of aquatic monocotyledons. The plants are slender, with submerged, linear, opposite to whorled leaves with sheathing bases. The flowers are minute and unisexual: the male flower consists of one stamen in a two-lipped perianth, the female of one carpel which is usually without perianth. The fruit is a tiny nut. There is one genus and 35 species, occurring in temperate and humid tropical regions.

naked pteropods *See* Gymnosomata.

Nandidae (leaf-fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of freshwater fish, which have a strongly compressed, deep body, and a rather pointed snout, emphasizing the low-slung mouth. The dorsal and anal fins are long, the short tail ending in a rounded tail-fin. Most species have irregular colour markings consisting of spots of different sizes and colours. *Monocirrhus polyacanthus* (leaf-fish), 8 cm, is a well camouflaged, voracious predator. Like other species, e.g. *Polycentrus schomburgki*, 10 cm, it is sometimes kept in aquariums. There are about 10 species, but the genera *Pristolepis* and *Badis* have also been placed in different families (Pristolepidae and Badidae). They are found in W. Africa, SE Asia, and S. America.

Nannopterum harrisi (Galápagos cormorant) *See* Phalacrocoracidae.

Nannostomus marginatus (pencil fish) *See* Lebiasinidae.

nannygai (*Trachichthodes affinis*) *See* Berycidae.

nano-plankton *See* plankton.

naphthalene acetic acid A synthetic auxin.

nappes In geology, a thrusted mass or folded body in which the fold limbs and axes are approximately horizontal (from the French *nappe*, meaning 'cover').

napthalene-acetic acid A synthetic auxin.

Narcissus (family Amaryllidaceae) Genus of bulbous herbs, with regular flowers borne singly or in groups on the tip of a leafless stem, and with a papery spathe around the flower or flower group. The flowers have six, similar perianth segments, and also a cup or trumpet-shaped corona surrounding the stamens. *Narcissus* species are much cultivated (as wild species and as hybrids or cultivars) for the fine flowers. There are some 35 species, occurring in Europe, W. Asia, and N. Africa.

Narcomedusina (order Trachyline) Suborder of Cnidaria in which tentacles arise some distance aborally to the margin of the umbrella and in which gonads are situated on the manubrium (projection around the mouth).

Nardia (order Jungermanniales) Genus of leafy liverworts, which includes *N. scalaris*, a species common in Britain. The stems are usually more or less prostrate, almost unbranched, often forming extensive patches. The leaves are more crowded towards the tips of the stems. Each leaf is broad, rounded, entire, and somewhat concave. *Nardia* is common on gravelly or sandy soils on heaths, moors, mountains, etc. It is calcifuge.

nares *See* nasal cavity.

narial pads Naked, muscular pads surrounding the nostrils (e.g. in some Microchiroptera).

narrow-mouthed frogs *See* Microhylidae.

narwhal (*Monoceros*) *See* Monodontidae.

nasal bone One of a pair of bones that together form the roof of the nasal cavity.

nasal cavity In tetrapods, a cavity in the head lined with mucous membrane and connected by passages (nares) to the mouth and to the exterior of the body. It contains the olfactory organ.

Nasalis larvatus (proboscis monkey) *See* Cercopithecidae.

Nasanov's gland Pheromone-producing gland in the abdomen of a worker honeybee (*Apis* species). It opens at the base of the last tergite via a partially eversible membrane, and is functional only in bees of foraging age (10 days old). During emission, the bee adopts a characteristic stance, with abdomen raised, gland exposed, and the wings beating to waft away a plume of scent. The gland secretes a mixture of scents (geraniol, nerolic and geranic acids, and citral) which have several functions

according to the context in which they are released. Thus in combination with 'queen substance' the Nasanov's gland scents recruit additional workers to a settled swarm; in the presence of disorientated bees the scent attracts them back to the hive. The scents are also emitted by foragers at a food source that does not have a characteristic scent of its own, and additional workers are recruited. Thus the Nasanov's gland scents may augment information conveyed by the round dance and waggle dance. The scents are also used to recruit workers to sources of water.

nasohypophysial sac In Agnatha, a cavity above the mouth formed from the nasal pit and the hypophysial sac, connected with the exterior by a single nostril, and performing an olfactory function.

Nasturtium (watercress; family Cruciferae) Genus of plants with pinnate leaves and spikes of white flowers. The elongated fruits have two convex valves. Watercress is cultivated for its edible leaves, used as a salad vegetable. There are only a few species, occurring in Europe, N. Africa, and W. Asia.

nasturtium (*Tropaeolum majus*) *See Tropaeolum*.

Nastus (family Gramineae, subfamily Bambusoideae) Genus of bamboos, most of which are scramblers in forest canopy. There are 15 species, occurring in the tropics with a remarkably disjunct range in the Mascarenes, in W. Malesia, and from New Guinea to the Solomons.

nasty Response of a plant organ to a non-directional stimulus, e.g. the opening or closing of flowers in response to changes in light intensity or temperature. The plant may respond by changes in cell growth or by changes in turgor.

nasus *See* nasute.

nasute Termite soldier that is equipped with a projection on the head (nasus). It squirts at enemies an adhesive or toxic fluid produced by the frontal gland.

natal dispersal *See* philopatry.

Natalidae (long-legged bats; order Chiroptera, suborder Microchiroptera) Family of very agile, insectivorous bats in which the large uropatagium is supported by very long legs, calcars, and the tail, which extends to its margin. The nose is simple, without a leaf, but has lateral tufts of hair. The ears are simple, separate, and very large. The bats are distributed throughout tropical N. and C. America and the W. Indies, and in tropical S. America east of the Andes. There is one genus, *Natalus*, with about eight species.

national park As defined by the IUCN (1975), a large area of land containing ecosystems that have not been materially altered by human activities, and including plant and animal species, landscape features, and habitats of great scientific interest, or of beauty, or recreational or educational interest: it is under the direct control of the state, and the public is allowed to visit it for inspirational, cultural, and recreational purposes. Implicitly, a national park is an area set aside in perpetuity for conservation, within which such public recreational activity is permitted as is compatible with the primary conservation objectives. British national parks do not comply strictly with the IUCN definition, since they comprise areas that have been altered significantly during a long period of human occupation and since they are still actively farmed and occupied, much of the land being owned privately rather than publicly. Land is so designated in order to maintain long-established, cultural landscapes. Similar schemes have been developed elsewhere, but are given distinctive and less confusing titles, e.g. 'parcs naturels et régionaux' in France, and 'greenline parks' in the USA.

native (indigenous) Applied to a species that occurs naturally in an area, and therefore one that has not been introduced by humans either accidentally or intentionally. Of plants found in a particular place, the term is applied to those species that occur naturally in the region and at the site.

native cats *See* Dasyuridae.

native poplar (*Codonocarpus cotonifolius*) *See Codonocarpus*.

native tamarind (*Diploglottis cunninghamii*) *See Diplogottis*.

natric horizon As defined by the USDA, a mineral soil horizon that is developed in a subsurface position in the profile, that satisfies the definition of an argillic horizon, and that also has a columnar structure and more than 15% saturation of the exchangeable cation sites by sodium.

Natrix maura (viperine snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snake, which grows to 96 cm, and which is either blotched or has an adder-like, zigzag pattern. It is distinguished from the adder by its round (not vertical) pupils. It eats mainly fish and amphibians. It is found near or in water in SW Europe and NW Africa.

Natrix natrix (grass snake, ringed snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snake, which sometimes exceeds 1 m in length. It is brown, olive-grey, or greenish, with a yellow collar on the nape of the neck. It feeds mainly on amphibians and fish. The female lays 8–13 eggs. It occurs in Europe (including England and Wales), NW Africa, and W. Asia.

Natrix tessellata (dice snake, tessellated snake; order Squamata, suborder Serpentes (Ophidia), family Colubridae) Species of snake, which rarely exceeds 1 m in length. It is greyish, brownish, or greenish, with dark brown or black blotches. It eats mainly fish and amphibians. It is found in or near water, from C. Europe to C. Asia.

natterjack toad *See Bufo calamita*.

natural Term that is applied to a community of plants and animals. 'Future-natural' describes the community that would develop were human influences to be removed completely and permanently, but allows for possible changes in climate or

site. 'Original-natural' describes a community as it existed in the past, with no modification by humans. 'Past-natural' describes the condition in which the present features are derived directly from those existing originally, with relatively little modification by humans. 'Potential-natural' describes the community that would develop were human influence removed, but the consequent succession completed instantly—future changes in climate or site are not taken into account. 'Present-natural' describes the community that would exist now had there been no human modification. Because of the dynamic nature of any ecosystem, this condition may not be identical to the last original-natural state before human intervention began.

natural immunity Immunity that has been inherited in contrast to one that has been acquired. If an individual acquires immunity by having the disease in question, as opposed to acquiring it as the result of vaccination, then that individual is said to have natural acquired immunity.

natural selection ('survival of the fittest') Complex process in which the total environment determines which members of a species survive to reproduce and so pass on their genes to the next generation. This need not necessarily involve a struggle between organisms.

natural turnover rate Normal rate of transfer of an element through the active part of a biogeochemical cycle. *Compare* man-induced turnover.

natural woodland Woodland comprising trees that have not been planted by humans, and where no human interference has occurred.

nature and nurture Synonyms for heredity and environment as they affect a character. Both may affect observed variation amongst individuals; only variations due to 'nature' are inherited, and it is these that form the subject of quantitative genetics.

nature conservation *See* biological conservation; and conservation.

nature reserve Area of land set aside for nature conservation and associated scientific research, usually with strong legal protection against other uses. Public access may be restricted partially or completely. The precise status and definition of reserves varies from one country to another. The relative merits of the many criteria that govern the selection of nature reserves have been discussed extensively in recent ecological literature. In Britain, a key objective is to maintain a fully representative range of habitats and their flora and fauna; this is done by means of national nature reserves (NNR), controlled by the Nature Conservancy Council, complemented by local nature reserves (LNR), of local rather than national or international interest and importance, managed by various agencies, especially by county naturalists' trusts, on behalf of local government. In the USA, major reserves are administered by the Bureau of Sports, Fisheries and Wildlife. The largest, established in 1960, is the Arctic National Wildlife Range, in Alaska, which covers 3.6 million hectares (8.9 million acres).

nauplius eye Single median eye comprising three- or four-pigment cup ocelli, sometimes with a lens, probably enabling the organism to determine the direction of a source of light for orientation. The median eye is typical of crustacean nauplius larvae. It may degenerate as the larva develops, or it may persist into the adult form.

nauplius larva The first, free-swimming, planktonic larva of most marine and some freshwater crustaceans. It has no evident segmentation. There is a single, median, 'nauplius' eye at the front of the head. There are only three pairs of appendages, the first and second antennae, and the mandibles. The second antennae and mandibles bear swimming setae. Additional trunk segments and appendages appear with successive moults, the increments proceeding from anterior to posterior. The late nauplius stages are often called metanauplii. The term 'postlarva' is applied to all immature crustaceans when the full complement of segments and appendages have developed. Some or all larval stages are absent in certain groups of Crustacea, and in others they may be considerably modified.

nautical mile Length of mile used in ocean navigation. It is internationally defined as being equal to 1852 metres.

nautiliconic Applied to the conch of a cephalopod when it is coiled and highly involute.

Nautilida (class Cephalopoda, subclass Nautiloidea) Only extant order of nautiloid cephalopods, whose extant members are involute nautilicones. The majority of nautilids have a narrow siphuncle in a sub-central position. Sutures vary from simple to very complex. *Nautilus* is the only extant genus. The order first appeared in the Middle Devonian.

Nautiloidea (phylum Mollusca, class Cephalopoda) Subclass of cephalopods which possess a multichambered, external shell composed of calcium carbonate, which is siphunculate and may be coiled. The gill structure is tetrabranchiate. Simple sutures are produced by contact between the internal septa and the shell wall. The subclass includes the oldest cephalopods, first recorded from Upper Cambrian rocks. They diversified and became common throughout the Palaeozoic, but were greatly reduced at the end of this era. Further diversification occurred in the Mesozoic, but the group dwindled again in the Cenozoic. There are more than 300 extinct genera and one extant genus, *Nautilus*, which dates from the Oligocene.

Nautilus *See* Nautilida; and Nautiloidea.

neap tide Tide of small range occurring every 14 days, near the times of the first and last quarter of the Moon when the Moon, Earth, and Sun are at right angles. The neap tidal range is 10–30% less than the mean tidal range.

Nearctic faunal region The fauna of N. America, south to Mexico. At the order and family level the fauna is essentially the same as that of the Palaearctic region, but some genera and more especially species are distinctive to the Nearctic. Because of their strong affinities, the Nearctic and Palaearctic regions are often grouped into one unit,

Holarctica, reflecting their former connection via the Bering land bridge.

nearest-neighbour analysis (nearest-neighbour measure) Method for testing the pattern of distribution of individuals. The mean nearest-neighbour distance for all, or for a random sample of, individuals in a given area is compared with the expected mean distance if the same individuals were randomly distributed throughout the area. The ratio of the two mean values (R) is a measure of the departure from randomness, and may be tested for statistical significance. The value of $R = 1$ indicates randomness; $R = 0$ indicates maximum aggregation; and $R = 2.149$ indicates maximum possible spacing, i.e. a hexagonal pattern.

nearest-neighbour measure *See* nearest-neighbour analysis.

nearest-neighbour sampling method Method of plotless sampling in which the distance is measured from the first individual (the nearest to the random sampling point), to its nearest neighbour. This permits the calculation of the density of individuals, or of its reciprocal, the mean area per individual.

near-natural community Vegetation community consisting wholly or predominantly of native species which, though modified by human use, has not been deflected from its natural course of succession. Examples include traditional wood-pasture and coppiced woodland. *Compare* semi-natural community.

near-shore current system System of currents caused by wave activity within and adjacent to the breaker zone. The current system includes: the shoreward mass transport of water; longshore currents; and seaward-moving rip currents. This wave-induced current system often has a reversing tidal current system superimposed on it.

nebular hypothesis Theory of the evolution of the solar system proposed by Kant and Laplace and now discarded. They considered that the Sun was a rotating, gaseous nebula which was contracting due to gravity. When centrifugal forces exceeded gravitational forces matter was thrown off, subsequently to cool and develop into the planets.

nebulosus From the Latin *nebulosus* meaning 'fog-covered', a form of stratus or cirrostratus cloud or cloudsheets in which clouds or sheets are rather indistinct, and seen as a nebulous layer. *See also* cloud classification.

Neckera (order Isobryales) Genus of mosses in which the shoots are typically flattened, and pinnately or bipinnately branched. The leaves are usually glossy and in some species are wrinkled transversely; they either lack a nerve or have a very short nerve visible under the microscope. There are about 120 species, found chiefly in tropical and subtropical regions. They grow on trees, rocks, and on the ground, usually preferring neutral or basic (alkaline) substrates.

necrosis The death of a circumscribed piece of tissue. Necrotic wounds in mammals are produced, for example, by the bite of *Loxosceles reclusa* (brown recluse spider).

necrotrophic Applied to a parasitic organism that obtains its nutrients from dead cells and tissues of its host organism.

Nectarinia (sunbirds; family Nectariniidae) Genus of small birds, the males of which have bright, metallic blue, green, red, and purple plumage. The females and some non-breeding males have a dull plumage. Sunbirds inhabit forest, bush, and clearings; feed on nectar and insects; and build nests suspended from branches. There are about 75 species, found in Africa, Asia, Indonesia, New Guinea, and Australia.

Nectariniidae (sunbirds, spiderhunters; order Passeriformes) Family of small birds, most of which have a long, narrow, pointed, decurved bill, which is partly serrated. They have short legs; short, rounded wings; and a short to long, square, rounded or graduated tail. Sunbirds have bright, metallic-coloured plumage, and are the Old World equivalent of hummingbirds. Spiderhunters are mainly brown. They inhabit forests, clearings, and bush, and feed on insects, spiders, nectar, and fruit. Their nests are built suspended from branches or leaves; some are sewn on to the under-sides of leaves. There are five genera, with about 117 species, many of them kept as cagebirds, found in Africa, Asia, the Philippines, Indonesia, and Australia.

nectocalyx In some Siphonophora, a bladder-like swimming bell.

nectophore *See* Calycophorina.

Nectria (family Hypocreaceae) Genus of fungi whose brightly-coloured fruiting structures are common on twigs and bark. *N. cinnabarina* forms pale pink conidial pustules measuring 1–2 mm across, which are replaced later in the year by red perithecial pustules. Some species can cause plant diseases, e.g. *N. galligena* causes apple canker.

Necturus maculosus (mudpuppy, water dog; order Urodela (Caudata), family Proteidae) Species of persistently neotenous salamanders, which occasionally grow up to 40 cm long. They are greyish-brown, with blue-black mottling. The three pairs of gills are retained throughout life. The four-toed limbs are small and weak. *N. maculosus* are carnivores on small fish and aquatic invertebrates. They occur in ponds and rivers in the eastern USA and in S. Canada.

needle (bot.) Linear, commonly pungent, leaf, as in many conifers.

needlefish *See* Belonidae.

needle grasses *See Stipa*.

needle ice (pipkrake) Columnar ice found beneath individual stones or patches of earth in the periglacial environment. It is a result of the relatively high thermal conductivity of such materials, leading to freezing under them when the temperature falls. Heaving of less than 0.1 m may occur by this process.

Neesia (family Bombacaceae) Genus of trees in which the fruit is a big, five-angled, tessellated capsule with the inner surface of the valves clothed in irritant hairs. There are eight species, occurring in rain forests from Thailand to Borneo.

negative feedback In a system, the mechanism by which a process is limited internally, i.e. without reference to factors outside the system. Ecologically such mechanisms favour the maintenance of equilibrium in organisms, populations, and ecosystems.

Neisseria (family Neisseriaceae) Genus of Gram-negative bacteria in which the cells are typically spherical and often occur in pairs with adjacent sides flattened. They are chemo-organotrophic. There are several species. They are parasitic on the mucous membranes of mammals. Some species are pathogenic: *N. gonorrhoeae* causes gonorrhoea, *N. meningitidis* causes meningitis. The organisms tend to be delicate and are easily killed by desiccation and by exposure to sunlight.

Neisseriaceae Family of Gram-negative bacteria, in which the cells are spherical or ovoid, and occur in pairs, groups, or short chains; flagella are absent. They are chemo-organotrophic. There are several genera, including parasitic and saprotrophic species.

nekron mud *See* gyttja.

nekton Free-swimming organisms in aquatic ecosystems. Unlike plankton, they are able to navigate at will. It includes fish, amphibians and large swimming insects.

Nelusetta ayraudi (chinaman leatherjacket) *See* Monacanthidae.

nema *See* Graptolithina.

Nemadactylus macropterus (jackass morwong) *See* Cheilodactylidae.

Nematocentris australis (W. Australian rainbowfish) *See* Melanotaeniidae.

Nematocentris fluviatilis (crimson-spotted rainbowfish) *See* Melanotaeniidae.

Nematocera (class Insecta, order Diptera) Suborder of Diptera (true flies) in which the adults usually have long, thin antennae of not less than six segments, which are more or less uniform, and unfused. If the antennae are short, members of the suborder may be recognized by their pendulous, multi-segmented palpi. The discal cell of the wing is generally absent, and the cubital cell, when present, is widely open. In many species the larvae have well-developed, biting mandibles. The pupae are obtect, and normally free. There are about 21 families with worldwide distribution.

nematocyst In Cnidaria, a pear-shaped sac with a lid (operculum), the outer end of the sac being extended to form a long, hollow thread which is stored coiled within the sac, immersed in a fluid. On stimulation the thread is expelled, as a weapon or to capture or hold prey, depending on the type of nematocyst. Some nematocysts are barbed and some inject venom.

Nematoda (eelworms, roundworms, threadworms; phylum Aschelminthes) Class of aschelminth worms (a phylum in some classifications) which vary greatly in size, from about 1 mm to 5 cm. The cuticle has flanges, and may also have ridges or spines. Morphologically they are all similar, but they occur as parasites in plants and animals, and as free-living forms. They are first known from rocks of Carboniferous age.

Nematognathi Older name for the order Siluriformes or catfish.

Nematomorpha (hairworms; phylum Aschelminthes) Small class of aschelminth worms, the vast majority of which are marine. Their narrow, hair-like bodies have a thick cuticle. All lack a true excretory system. The young are parasitic, and mature individuals are free-living in fresh water. They are first recorded from the Eocene.

Nemeobiidae *See* Riodinidae.

Nemertini (proboscis worms, ribbon worms) Phylum of unsegmented, non-parasitic worms which are bilaterally symmetrical and elongate. Adults are ciliated and possess a thin, retractile proboscis. The mouth and brain are well developed, the coelom is indistinct. Most are marine, although freshwater and terrestrial forms occur. Most are not hermaphrodites. The first fossil forms occur in the Middle Cambrian Burgess Shales of British Columbia, Canada.

Nemichthyidae (snipe eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of marine deep-sea eels, which have a very long, ribbon-like body and a thin, beak-like snout. One of its better-known species, *Nemichthys scolopaceus*, may reach a length of 1.2 m. There are about 10 species, distributed worldwide.

Nemipteridae (threadfin bream; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have a compressed and slender body, somewhat produced snout, and a single, continuous dorsal fin. The pelvic fins are situated just behind the pectorals. The forked tail-fin may show a trailing filament off the upper lobe in some species. Several species are recognized as important food fish, including *Nemipterus hexodon* (40 cm), the ornate threadfin bream, known in Australia as the yellow-banded butterfly-fish. Nemipteridae are distributed throughout the Indo-Pacific region. There are many species.

Nemipterus hexodon (ornate threadfin bream, yellow-banded butterfly-fish) *See* Nemipteridae.

Nenga (family Palmae) Genus of solitary palms, in which the leaves are pinnate, with a pronounced crown-shaft. The inflorescence is sparsely branched. The flowers are spirally arranged, a female flanked by two males. The fruit wall is fleshy, and showy. There are two species, found in Sumatra and Malaya.

ne-ne (*Branta sandvicensis*) *See Branta*.

Neobalanocarpus (formerly *Balanocarpus*; family Dipterocarpaceae) Genus of one species, *N. heimii*, a tree of lowland rain forests of Malaya and

Sumatra, which provides the highly durable, heavy, hardwood timber chengal. It is close to *Hopea*.

neocatastrophist *See* catastrophism.

Neoceratiidae (class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Monospecific family of deep-sea fish that have a large head, a large mouth, and small eyes. The jaws are equipped with many long and slender teeth. The single dorsal, caudal, and anal fins have a rounded profile, while the pectorals are small. Unlike other lophiid deep-sea species, no illicium is present on the head of *Neoceratias spinifer* (6 cm). However, as in other lophiids, the females are larger than the males, and the males may form a parasitic relationship with their female sex partners. They are found in all oceans.

Neocythus rhomboidalis (spiky dory) *See* Oreosomatidae.

neo-Darwinism *See* Darwin; and modern synthesis.

Neodrepanis (false sunbirds) *See* Philepittidae.

Neofelis nebulosa (clouded leopard) *See* Felidae.

Neofidelia *See* Fideliidae.

Neogastropoda (phylum Mollusca, class Gastropoda) Order of prosobranch gastropods which may have one pectinibranch gill, or less commonly two. A proboscis develops and there is a large osphradium. The nervous system is concentrated. Sexes are separate. The shell has an obvious siphonal notch or canal (i.e. in contrast to the entire aperture in Mesogastropoda), and has an operculum. Most neogastropods are carnivorous. They first appeared in the Cretaceous.

Neogea Neotropical zoogeographical region comprising C. and S. America. *Compare* Arctogea; and Notogea; *see also* faunal region.

Neogene Term used to describe collectively the last two epochs of the Tertiary, i.e. the Miocene and Pliocene, and sometimes including the Quaternary in addition.

Neognathostomata (class Echinoidea) Name given to a group of irregular echinoids comprising the orders Galeropygoida, Cassiduloida, Oligopygoida, and Clypeasteroida.

neo-Lamarckism The Chevalier de Lamarck (Jean Baptiste Pierre Antoine de Monet, 1744–1829) believed that evolution proceeds because characteristics acquired in one generation are transmitted to the next. His original ideas are no longer accepted, but variants of them have continued to appear right up to the present. These newer versions are referred to as 'neo-Lamarckism'.

Neolampadoida (class Echinoidea) Small and poorly known order of irregular echinoids, with non-petaloid ambulacra, which may have cassiduloid ancestry. They are known as fossils from the Upper Eocene, and are extant in tropical seas.

Neolarra *See* Anthophoridae.

Neolinognathidae (order Phthiraptera, suborder Anoplura) Family of sucking lice which are parasitic on Macroscelidae (elephant shrews). The species in this family can be distinguished from all other lice by their possession of a single pair of abdominal spiracles, on segment VIII. Most other lice have a pair of spiracles on each of segments III to VIII, and those that have fewer than six pairs have lost those on segment VIII. The family comprises a single genus, *Neolinognathus*, with two species.

Neoloricata (class Amphineura, subclass Polyplacophora) Order of extant polyplacophorans, some of which have the articulamentum present as insertion plates. Advanced forms possess a mesostracum layer to the valves. They first appeared in the Carboniferous.

Neomeniida (class Amphineura, subclass Aplacophora) Order of spiculose aplacophorans, which possess a groove on the central surface containing a ciliated ridge. They have a simple mantle cavity with internal folds for respiration. True gills do not occur. Individuals are bisexual. They are Recent in age.

neomycin Aminoglycoside antibiotic produced by *Streptomyces fradiae*, which functions by interfering with ribosomal activity and so causing errors in the reading of the m-RNA.

neon tetra (*Paracheirodon innesi*) *See* Characidae.

Neoophora (phylum Platyhelminthes, class Turbellaria) Subclass of platyhelminth worms, most of which occur in freshwater or marine habitats, but some of which are terrestrial. The ovary is divided.

neopallium Part of the roof of the cerebrum, forming the main part of the cerebral cortex in humans. It is concerned with general co-ordination and learned behaviour rather than with smell.

Neopterygii Older, but still current, name for a large group of bony fish (Osteichthyes) including the infraclasses Holostei (e.g. bowfin, Amiidae) and Teleostei (e.g. perch, Percidae).

Neorhabdocoela *See* Rhabdocoela.

Neoscopelidae (class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine, deep-sea fish which resemble the lanternfish (Myctophidae) but which have a somewhat pointed snout. A few light organs are present on the slender body. Generally small fish (20 cm), they have a single, short dorsal fin as well as an adipose fin opposite the anal fin; the pelvic fins are just behind the dorsal fin. There are about five species, distributed worldwide.

Neosittidae *See* Daphaenosittidae.

Neostethidae (class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of brackish-water and freshwater fish which have a rather slender and almost transparent body. In this peculiar family the pelvic fins of the males are modified to form a complex copulatory apparatus (the pelvic fins are absent in the females). The anus is located far forward. Most species are very small (4 cm) and are found in coastal creeks in SE Asia. There are about 16 species.

neoteny Slowing down of somatic development, so that sexual maturity is achieved while the organism still looks like a juvenile; this leads to paedomorphosis. Since the juvenile stages of many organisms are less specialized than the corresponding adult stages, such shifts allow the organisms concerned to switch to new evolutionary pathways. The word comes from the Greek *neos* (meaning 'youthful'). Neoteny is common among urodeles (class Amphibia).

Neotropical faunal region Region which includes S. and C. America, including S. Mexico, the W. Indies, and the Galápagos Islands. Much of the area was isolated for the greater part of the Tertiary Period, which explains the distinctiveness of the fauna and the survival of ancient forms of mammals, e.g. the marsupials and edentates.

Neotropical floral kingdom (Neotropical floral realm) One of the major floral subdivisions of the world, corresponding with C. and S. America, with the exception of the southern tip which is included in the Antarctic kingdom. The floristic distinctiveness results from the isolation of S. America from other land masses for much of Cenozoic time.

neotype Specimen chosen to act as the 'type' material subsequent to a published original description: this occurs in cases where the original types have been lost, or where they have been suppressed by the ICZN.

Nepenthaceae (pitcher plants) Family of carnivorous and tropical herbs and shrubs, which are often woody climbers or epiphytes. The alternate leaves are without stipules. Tendrils, formed by projections from the leaf midrib, assist in climbing. The pitcher forms on the end of the tendril, with a lid covering the mouth. The pitcher is inwardly curved, with nectar glands at the entrance and a slippery internal surface. It is often brightly coloured. The colour and nectar attract insects, which slip into the pitcher; they are unable to climb out and so drown in the water that has accumulated at the base of the pitcher. The plant is able to absorb the nutrients from the dead insects. The flowers are dioecious and held in a spike. They are small and brightly coloured, red, yellow, or green, with three or four sepals and no petals. The stamens of the male flower are united into a column. The female flower has a short style, and a superior ovary with four locules, each with numerous ovules. The fruit is a thickened capsule and holds the small, light seeds with a fleshy endosperm. The family is related to other insectivorous families, such as the Droseraceae. There is one genus, *Nepenthes*, and about 70 species occurring in tropical Asia, Australia, Madagascar, and the Seychelles. Some authorities place the Seychelles species *N. pervillei* in a separate genus, *Anurosperma*.

Nepenthes (pitcher plants) *See* Nepenthaceae.

nephanalysis Interpretation of cloud type and amount from satellite pictures in facsimile or digitized form.

nepheline Mineral, specific gravity 2.6, hardness 5.0–6.0, and with the chemical composition $Na(AlSiO_4)$, whose name is derived from the Greek for 'cloud'. It occurs almost exclusively in magmatic, silica-poor, alkaline rocks, in association with alkaline feldspars and alkaline pyroxenes; but also in pegmatites, associated with zircon, sphene, and illmenite. It can be colourless, grey, yellowish, brownish, reddish, or greenish, and has a vitreous to greasy lustre. It crystallizes in the hexagonal system. The crystals are normally prismatic, short, and columnar; or thick and tabular; or found as coarse, granular aggregates. Nepheline is used extensively in the glass and ceramics industries.

Nephelium (family Sapindaceae) Genus of small trees, in which the leaves are pinnate. The fruit is indehiscent, and the pericarp leathery, warty, or spiny, with one large seed enveloped in a juicy aril. Several species are cultivated for their edible fruit, especially *N. lappaceum* (rambutan). There are 35 species, occurring from Burma to W. Malesia.

nephridium In many invertebrates, an organ probably concerned with excretion and the regulation of the water content of the body, consisting of a tube from the coelom to the exterior of the body.

nephrocoel Coelomic cavity in a nephrotome.

nephrocyte In most Arthropoda, large phagocytic cells that accumulate waste products.

Nephromiaceae (order Lecanorales) Family of lichens in which the thallus is foliose. The apothecia are formed on the lower surface of the thallus on lobes which turn upwards. The spores are brown and multiseptate. There is one genus, *Nephroma*, found in humid regions on a variety of substrates.

nephromixium In many Polychaeta, a composite structure formed from the attachment of a nephridium (excretory organ) to a coelomoduct (through which gametes move to the exterior), so that excretory products and gametes reach the exterior through the same pore.

Nephropidae (lobsters; subclass Malacostraca, order Decapoda) Family of lobsters, which have large chelipeds and are similar in form to crayfish. Males are generally much larger than females.

Nephrops norvegicus (Dublin Bay prawn, scampo (pl. scampi), Norway lobster; subclass Malacostraca, order Decapoda) Crab, similar to *Homarus americanus* (giant American lobster) and *H. gammarus* (common lobster), but which has smaller and more elongate chelipeds. The female reaches a length of 17 cm and the male 22 cm. It lives off Atlantic and Mediterranean shores at depths of 40–80 m, and prefers soft, sandy substrates.

nephrostome 1 In Polychaeta, the opening of the nephridium into the coelom. 2 (nephrocoelostome) In excretory systems of vertebrate embryos and in vertebrate kidneys, the opening of an excretory tubule into the cavity of Bowman's capsule.

nephrotome The part of the mesoderm (germ layer in triploblastic animals, composed of cells that have moved from the surface to the interior) that will differentiate to form kidney and gonad tissues.

Nepidae (water scorpions; order Hemiptera, suborder Heteroptera) Family of aquatic bugs which live submerged, breathing through a bristle-like, tubular tail that reaches the surface. Being poor swimmers, they lie in wait for their prey, which they seize with the front pair of legs. They live in still or slow-moving waters. There are about 200 species, occurring on all continents.

Nepticulidae (order Lepidoptera) Family of minute, primitive moths, with a wing-span sometimes less than 5 mm. Adults are metallic in colour or drab, and have much reduced wing venation, and a short proboscis. The antennal scape is expanded into a prominent 'eye-cap'. The larvae are generally leaf-miners with legs and prolegs hardly visible. Pupation occurs in a cocoon, usually in the soil. The family has a global distribution.

neritic province *See* neritic zone.

neritic zone (neritic province) The shallow-water, or near-shore, marine zone extending from the low-tide level to a depth of 200 m. This zone covers about 8% of the total ocean floor and is the area most populated by benthic organisms, due to the penetration of sunlight to these shallow depths.

Nerium (family Apocynaceae) Genus of plants which includes *N. oleander* (oleander). There are three species, occurring from the Mediterranean region to Japan.

Nerophis ophidion (straight-nosed pipefish) *See* Syngnathidae.

nerve cord In Metazoa, a bundle of nerve fibres along the longitudinal axis of the body. In most invertebrates there are two solid nerve cords, located ventrally, with ganglia corresponding to each segment. In Chordata the nerve cord is located dorsally and in vertebrates it is the spinal cord.

nervous system In all multicellular animals except Porifera, a network of nerve cells, linked together by thread-like processes, through which electrochemical impulses transmit information to and from sense organs, muscles, etc. This is the means by which the activities of the animal, and its awareness of and reaction to events outside itself, are co-ordinated.

nest-building frogs *See* Leptodactylidae; and Rhacophoridae.

nestling 1 Young bird, before it leaves the nest. 2 Mode of life adopted by certain pelecypods, which live in crevices and depressions in hard substrata, not excavated by the pelecypod itself.

net community productivity *See* primary productivity; and oxygen method.

net plankton *See* plankton.

net primary productivity (NPP or P_n) *See* primary productivity.

net slime moulds Name sometimes applied to organisms that form a net plasmodium. Such organisms are sometimes placed in the order Labyrinthulales.

Nettastomidae (duckbill eel, witch eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of marine, deep-sea, eel-like fish, which have a very slender, elongate body, long and thin jaws, and a large mouth with sharp teeth. The pectoral fins are absent, but the dorsal and anal fins are long and low. Duckbill (or witch) eels are found only at great depth in the oceans. There are about 16 species.

nettle *See Urtica*.

net-winged beetle *See* Lycidae.

neural arch Bony arch located on the centrum of each vertebra and forming a channel (the neural canal) through which the spinal cord runs.

neural canal *See* neural arch.

neural spine The median dorsal projection from the neural arch of a vertebra.

neuromast In fish and some Amphibia, the basic receptor units of the acoustico-lateralis system. The receptor cells are surrounded by a clump of supporting cells, the units being covered by a gelatinous capsule or cupula. Physical changes in the environment are relayed to the brain by means of electrical discharges through special nerve fibres. *See* acoustico-lateralis system.

neuron *See* neurone.

neurone (neuron) Nerve cell; in animals, a nucleated cell through which impulses are conducted, being transferred from one neurone to the next at a synapse. Neurones are commonly long and thread-like in shape.

neuropodium In Polychaeta, the ventral division of the parapodium.

Neuroptera (ant lions, lacewings, mantid flies, owlflies; class Insecta, subclass Pterygota) Order of endopterygote insects which have simple, biting mouthparts. The antennae are conspicuous and multi-segmented, and the two pairs of large, equal or subequal wings are lace-like, divided into many small cells by numerous cross veins. The larvae are predacious or parasitic, with distinctive, sickle-shaped, sucking jaws. Pupation occurs in a silken cocoon. The silk is produced from modified excretory tubules opening into the hind gut of the larva and is extruded from the anus, rather than being produced by salivary glands. Many species are highly coloured and patterned, sometimes with dense hairs, and most can be recognized by the highly branched terminal portions of the main veins (end-twigging). With the exception of the Hymenoptera, few other insect groups are more beneficial to humans, since adults and larvae are predacious on a vast range of sap-sucking insects (e.g. aphids and psyllids), and others on lepidopteran eggs and larvae, mites, and immature dipterans. The order is represented throughout the world.

neurosecretion Secretion by nerve cells of chemical compounds, including neurotransmitters and neurohormones.

Neurospora (family Sordariaceae) Genus of fungi, species of which are commonly used in genetic and biochemical studies on fungi. They are saprotrophic, and found chiefly on rotting vegetation or

on burnt ground. They can cause spoilage of bread in bakeries.

Neuroterus quercusbaccarum (superfamily Cynipoidea, family Cynipidae) Species of small, black wasps, the commonest *Neuroterus* species in Britain, which form oak spangle galls on the leaves of *Quercus robur*. The agamic (asexual) females emerge from the spangle gall in spring and lay eggs on the male catkins and young leaves. The rounded, green galls thus caused give rise to the males and females of the sexual generation.

neurotoxin Toxin that affects the functioning of the nervous system.

neurotransmitter Substance that functions in the transmission of nervous impulses. Although numerous substances have been implicated in neurotransmission, the two most widespread and best understood systems involve acetylcholine and noradrenaline, the so-called cholinergic and adrenergic systems respectively.

neuston Organisms resting or swimming on the surface of an aquatic ecosystem.

neutralism Situation in which two species populations coexist, with neither population being affected by association with the other.

neutrality theory of evolution (neutral-mutation theory) This asserts that many genetic mutations are adaptively equivalent (effectively neutral), and do not affect significantly the fitness of the carrier. Thus they can become fixed in the genome at a random rate. Changes in their frequencies are due more to chance than to natural selection. The theory applies only to protein evolution and does not deny the role of natural selection in shaping morphological and behavioural attributes. *See also* molecular evolution.

neutral-mutation theory *See* neutrality theory of evolution.

neutral soil Soil with a pH value of 6.6–7.3.

neutrophilous Preferring a habitat that is neither acid nor alkaline.

névé *See* firn.

Nevskia Genus of Gram-negative bacteria not assigned to any taxonomic family. Cells are rod-shaped. Young cells may lack slime and be motile, but in older cells lop-sided secretion of slime results in the formation of a colourless stalk on one side of the cell. The stalk branches as the cell divides, so that a colony of cells linked by branching stalks is eventually formed. Colonies are found floating on water surfaces in a range of freshwater habitats.

New Caledonia floral region Part of Good's (1974) Polynesian subkingdom, within his Palaeotropical kingdom, which also includes Lord Howe and Norfolk Islands. It has a remarkably rich flora, with a qualitatively high degree of endemism. Some of the endemic genera, of which there are well over 100, constitute separate families (or nearly so).

Newcastle disease Acute, infectious disease which affects birds, including domestic fowl. Although not necessarily fatal, the disease is economically important since affected birds are less productive. The disease affects mainly the respiratory tract, but the nervous system may become involved. Mortality rates vary. It is caused by a paramyxovirus.

New Guinea creeper (*Mucuna bennettii*) *See Mucuna*.

New Guinea walnut Timber of *Dracontomelum* (family Anacardiaceae), one of the most valuable timbers of that region.

New Red Sandstone Name given to the terrestrial red-bed deposits that overlie the Carboniferous. These deposits are of Permo-Triassic age.

New South Wales sassafras (*Doryphora sassafras*) *See Doryphora*.

newt *See* Salamandridae.

New World blackbirds *See* Icteridae.

New World monkeys *See* Ceboidea.

New World vultures *See* Cathartidae.

New World warblers *See* Parulidae; and *Vermivora*.

New Zealand flax (*Phormium tenax*) *See Phormium*.

New Zealand floral region Part of Good's (1974) Antarctic kingdom. Approximately 30 genera are known to be endemic to it, but the surprisingly large number of endemic species (about 75% of the total) belong very largely to non-endemic genera. Although antipodal to the British Isles, New Zealand has a flora that is considerably larger.

New Zealand wrens *See* Xenicidae.

ngali *See Canarium*.

niacin *See* nicotinic acid.

niche (ecological niche) Functional position of an organism in a community, together with its environmental position with respect to factors such as acidity, and temperature, etc., and the particular spatial habitat that the organism occupies.

Nicolettidae *See* Thysanura.

nicotinamide adenine dinucleotide (NAD, diphosphopyridine nucleotide, DPN) Derivative of the vitamin nicotinic acid, which functions as a coenzyme for various dehydrogenase enzymes involved in cellular respiration. It acts as an electron carrier in respiratory-chain phosphorylation.

nicotinamide adenine dinucleotide phosphate (NADP) Phosphorylated derivative of NAD, which functions as a hydrogen acceptor in the light stage of photosynthesis and is subsequently involved in the reduction of carbon dioxide in the dark reactions. It is a coenzyme in the reaction involving the oxidation of ferrodoxin by NADP reductase.

Nicotinia (tobacco; family Solanaceae, tribe Cestreae) Genus of annual and perennial herbs with leaves of varying shape, without stipules. The flowers are regular and composed of five sepals and five petals fused to form a tube. The stamens are attached to the corolla; the ovary is superior with two fused carpels and one style. The fruit is a berry

with seeds containing a copious endosperm. *N. tabacum* is the cultivated tobacco. Many species contain the highly toxic alkaloid nicotine, which is a powerful insecticide. Some species are cultivated for their bright flowers. There are about 50 species, and the genus is represented in Australia, the S. Pacific, and in subtropical regions of N. and S. America.

Nicotinia tabacum (tobacco) *See Nicotinia*.

nicotinic acid (niacin) One of the B vitamins. It is unique among this group in that it is synthesized by animal tissues, from tryptophan. A deficiency of this vitamin results in the disease pellagra.

nictitating membrane Lid-like membrane attached to the anterior corner of the eye. When drawn across the eye it reduces illumination of the retina. It is common in Reptilia and Aves, and present in some Mammalia and in many sharks, e.g. those of the family Carcharhinidae, which includes the tope (*Galeorhinus galeus*) and the blue shark (*Prionace glauca*).

nictonasty (sleep movement) Diurnal, nastic movement, e.g. the opening of certain flowers in the day and their closing at night.

nidicolous Appplied to a young bird that stays in the nest until it is able to fly. Nidicolous young are usually naked and incapable of locomotion.

nidifugous Applied to a young bird that leaves the nest on hatching or soon after. Nidifugous young are down-covered and capable of locomotion.

Nidulariales (class Gasteromycetes) Order of fungi, in which the spore-bearing tissue is organized into one or more spherical or flattened structures, called peridioles, contained within a fruit body which may be spherical, cup-shaped, or funnel-shaped. There are several genera, found on the ground, on dung, on wood, etc.

night-hawks *See* Caprimulgidae; and Caprimulgiformes.

night herons *See Nycticorax*.

nightingales *See Luscinia*.

nightjars *See* Caprimulgidae; Caprimulgiformes; and *Caprimulgus*.

night lizards *See* Xantusiidae.

night monkey (*Aotus trivirgatus*) *See* Cebidae.

Nile bichir (*Polypterus bichir*) *See* Polypteridae.

Nile crocodile *See Crocodylus niloticus*.

nimbostratus From the Latin *nimbus*, 'rain', and *stratus*, 'spread out', a dark or grey cloud that obscures the Sun, associated with more or less continuous rainfall which makes the base diffuse. *See also* cloud classification.

nine-awn *See Enneapogon*.

ninhydrin (triketohydrindene hydrate) Compound which reacts with the free alpha-amino groups of amino acids, peptides, and proteins to yield coloured compounds, usually blue or purple. Ninhydrin is therefore used in the chromatographic detection and quantification of amino acids and peptides.

niobite *See* columbite.

nit Name given to the eggs of lice (order Phthiraptera), particularly to those of the human body and head lice, *Pediculus humanus* and *P. capitis*. Eggs are cemented to the hair or feathers of the host and are very difficult to dislodge. Before hatching they are brownish-yellow, but afterwards air enters and they become silvery-white; it is in the latter form that eggs of *P. capitis* are generally recognized. The hatched eggs of some bird lice are used by mites, which enter them to shed their skins.

Nitidulidae (pollen beetles, sap beetles, dried-fruit beetles; class Insecta, order Coleoptera) Family of small, rounded, flattened beetles, 1–7 mm long, with elytra that are pubescent and short, exposing the terminal segments. The antennae have three-jointed clubs. The legs are often wide and flattened. Larvae are white and cylindrical, with well-developed legs. They feed on pollen and nectar, fermenting fruit, sap, carcasses. Some are associated with fungi, others are predatory on insects. *Carpophilus hemipterus* is a pest of dried fruits and may damage ripe fruit in orchards. There are 2200 species.

Nitraria (family Zygophyllaceae) Genus of halophytic shrubs and herbs in which the leaves are thickened or leathery, and usually opposite, with stipules. The flowers are bisexual, regular, and solitary, paired or in cymes. There are four or five overlapping sepals and a similar number of petals. The stamens are in whorls of five. The superior ovary usually has five fused and winged carpels. The fruit is a capsule, drupe, or berry, and the seeds contain the embryo surrounded by endosperm. Some fruits are edible. There are seven species, occurring in salt deserts of SE Australia, S. Russia, and the Sahara.

nitratine *See* Chile saltpetre.

nitre Mineral, specific gravity 2.2–2.3, hardness 1.5–2.0, and with the chemical composition $NaNO_3$, which occurs in very arid conditions where vegetation is very sparse. Little precipitation is required to wash an incrustation of nitre into hollows, where it forms saltierras or massive deposits. It is found in association with evaporite minerals of the arid desert type, e.g. gypsum, halite, and occasionally iodates. It is white, grey, reddish-brown, or lemon-yellow, and has a vitreous lustre. It crystallizes in the trigonal system. Usually it forms granular crusts and uneven masses. It is used as a fertilizer.

nitrification Oxidation of ammonia or nitrite to nitrate by chemolithotrophic bacteria of the family Nitrobacteraceae.

Nitrobacteraceae Family of Gram-negative bacteria in which the cells are variously shaped, and may or may not bear flagella. They are characterized by their ability to obtain energy from the oxidation of either ammonia or nitrite (according to species), and typically they use carbon dioxide as their sole source of carbon. Growth can occur only in the presence of air. There are several genera,

found in soil, and in freshwater and marine environments.

nitrogen (N) Element essential to all plant and animal life. It is found reduced and covalently bound in many organic compounds, and its chemical properties are especially important in the structures of proteins and nucleic acids. Nitrogen-deficient plants are chlorotic and etiolated, with the older parts becoming affected first.

nitrogen cycle Description of the balance, changes, and nature of the nitrogen-containing compounds circulating between the atmosphere, the soil, and living matter.

nitrogen fixation The incorporation of gaseous molecular nitrogen into nitrogenous compounds. In nature this occurs during thunderstorms by means of the electrical energy released as lightning, by photochemical fixation in the atmosphere, and by the action of nitrogen-fixing micro-organisms, especially bacteria and algae. Free-living nitrogen-fixing soil micro-organisms include *Azotobacter* species, *Clostridium* species, and in wet and aquatic habitats cyanobacteria, e.g. *Nostoc*, which generally are less abundant than symbiotic nitrogen-fixing micro-organisms. These include *Rhizobium* species, which form the characteristic nodules of leguminous plants. The bacteria supply the legume with nitrate, and receive carbohydrate from the legume. Certain non-leguminous plants, e.g. *Alnus* species (alder), *Myrica* species (bog myrtle), and *Casuarina*, typically plants of poorly drained and nutrient-depleted habitats, form symbiotic associations with actinomycetes that are nitrogen-fixing bacteria. The other main type of symbiotic nitrogen-fixing association occurs in lichens, in which the algal partner is a nitrogen-fixing cyanobacterium.

nivation Complex of surface erosional processes acting under a snow cover. It includes gelifraction, and the removal of shattered debris by solifluction and the movement of melted snow. It is an initial process in cirque development.

noble rot Rot of grapes caused by the fungus *Botrytis cinerea*; infected fruit is used to make high-quality wines.

Nocardiaceae (order Actinomycetales) Family of aerobic bacteria in which rudimentary or well-developed mycelium sooner or later fragments into rod-shaped or ovoid cells. There are two genera, and many species. They are facultative parasites or saprotrophs, found in soils, marine sediments, etc.

Noctilionidae (bulldog bats, fish-eating bats, hare-lipped bats; order Chiroptera, suborder Microchiroptera) Family of large bats in which the legs are long, the feet very large and equipped with strong claws, the wings long and narrow. The tail passes through the uropatagium. The ears are funnel-shaped, large and separate, the nose simple, the lips full and divided by a fold of skin to give a 'hare-lip' appearance. The bats are distributed throughout tropical America. There is one genus, *Noctilio*, and two species, one of which is insectivorous; the other (*N. leporinus*) feeding mainly on fish, which it seizes from the water with its claws and transfers to its mouth in flight.

noctilucent clouds (luminous night clouds) Type of clouds, occurring at 80–85 km altitude, near the upper limit of the stratosphere, characterized by a blue to yellow hue, and similar in appearance to cirrostratus. The clouds are seen on summer nights at latitudes between about 50° and 65° N and S; they move rapidly, at speeds up to 300 knots, often in a wave formation.

Noctuidae (noctuids, owlets, underwings, cutworms, armyworms; order Lepidoptera) Huge family of small to large moths, which are usually drab, sometimes with eye-spots. The proboscis is usually well developed. Larvae are not hairy. Pupation occurs below ground. The family includes serious pests, e.g. cutworms, stem borers, and foliage strippers. There are about 20 000 species, with a worldwide distribution.

noctuids *See* Noctuidae.

nocturnal ground beetle *See* Tenebrionidae.

nocturnal radiation The long-wave radiation from the surface of the Earth at night that is in excess of the incoming radiation from the atmosphere. *See also* atmospheric window; radiation budget; and terrestrial radiation.

nodal analysis *See* inverse analysis.

node On the stem of a plant, the point of attachment of a leaf or leaves.

nodule Spherical or oval concretion.

nodum In plant ecology, a characteristic vegetation unit. The term was first applied by M. E. D. Poore (1956) to similar sites grouped together using modified, traditional, phytosociological techniques. It was applied by J. M. Lambert and W. L. T. Williams (1962) to vegetation units doubly defined in nodal analysis, i.e. cases in which examination of groups identified by normal and inverse classification of a data set showed complete coincidence of indicator sites and species. A sub-nodum occurs when coincidence of indicator parameters occurs in one direction only. *See also* inverse analysis.

noisy scrub-bird (*Atrichornis clamosus*) *See* Atrichornithidae.

Nolanaceae Family of herbs and low shrubs with fleshy, alternate, simple leaves, often with glandular hairs, and without stipules. The regular flowers are bisexual, solitary, and axillary. There are five fused and persistent sepals. The corolla is five-lobed, blue, pink, or white, and unfolds from a pleated bud to form a bell or funnel shape. The stamens are unequal. The style is single with a lobed stigma. The superior ovary has five carpels, divided into many segments. The fruits are nutlets and the seeds contain a curved or spiral embryo, and endosperm. Some species are ornamentals. The family is related to the Solanaceae. There are two genera, comprising 85 species, represented on the west coast of S. America, often as seashore plants.

Nomada *See* Anthophoridae.

Nomadacris septemfasciata (red locust) *See* locust.

Nomeidae (driftfish, man-of-war fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish (sometimes included in the Stromateidae), which have oval bodies, large eyes, two separate dorsal fins, and forked tail-fins. Species such as *Nomeus gronovius* (man-of-war fish) and (*Psenes arafurensis* (eyebrow fish) are sometimes found swimming among the tentacles of *Physalia physalis* (Portuguese man-of-war) of the order Siphonophora. There are about 15 species, found in tropical and subtropical seas.

nomen conservandum Name, unacceptable under the regulations of the ICZN code, that is made valid using specified procedures, either with original or altered spelling.

nomen correctum Name with intentionally altered spelling required or allowed by the ICZN code but not requiring a transfer from one taxon to another.

nomen imperfectum Name that, as originally published, meets all the mandatory requirements of the ICZN code, but that contains a defect needing correction, e.g. incorrect original spelling.

nomen inviolatum Name that, as originally published, meets all the mandatory requirements of the ICZN nomenclature code and is not subject to any sort of alteration.

nomen nudum Name that, as originally published, fails to meet all of the mandatory requirements of the ICZN code and thus has no status in the nomenclature, even if corrected.

nomen oblitum Forgotten name. The name of a senior synonym that has not been used in the zoological literature for at least fifty years. Such names are not to be used unless permission is sought first from the ICZN.

nomen perfectum Name that, as originally published, meets all of the requirements of the ICZN code, needing no correction of any kind, but which nevertheless is validly alterable by a change of ending.

nomen substitutum New, replacement name, published as a substitute for an invalid one such as a junior synonym.

nomen translatum Name derived by a valid change of a previously published name as a result of transfer from one taxonomic level to another within the group to which it belongs.

Nomeus gronovius (man-of-war fish) *See* Nomeidae.

Nomia *See* Halictidae.

Nomioides *See* Halictidae.

non-biting midges *See* Chironomidae.

non-competitive inhibition Irreversible inhibition of the activity of an enzyme, brought about by the presence of an inhibitor that is generally structurally unrelated to the normal substrate.

non-cyclic phosphorylation The light-requiring part of photosynthesis in higher plants, in which oxygen is consumed and an electron donor is required. It consists of two photoreactions, resulting in the synthesis of ATP and $NADPH_2$.

non-frontal depression Low-pressure system that does not develop from a frontal wave as do typical mid-latitude frontal cyclones (or depressions). Most tropical cyclones are non-frontal. Various conditions can lead to the formation of depressions without frontal characteristics. *See also* cold low; lee depression; polar depression; and thermal low.

non-hierarchical classification method *See* hierarchical classification method.

non-parametric test *See* statistical methods.

non-polar molecule Molecule in which the electrons are shared equally between the nuclei. As a result the distribution of charge is even and the force of attraction between different molecules is small. Non-polar molecules show little reactivity.

non-renewable resource *See* finite resource.

nonsense mutation Mutation that alters a gene so that a nonsense codon is inserted. Such a codon is one for which no normal tRNA molecule exists: the codon therefore does not code for an amino acid. Usually a nonsense codon causes the termination of translation (i.e. the end of the polypeptide chain). Three nonsense codons are recognized, and are called the amber, ochre, and opal codons.

noradrenalin (norepinephrine) Catecholamine hormone, secreted by the adrenal medulla, which has effects similar to, but less pronounced than, those of adrenalin. It elicits a wide variety of responses, including an increase in blood-sugar level due to its stimulation of the breakdown of glycogen.

norepinephrine *See* noradrenalin.

Norfolk Island pine *See Araucaria*.

nori Japanese name for the edible seaweed *Porphyra* which, in Japan, is cultivated on bamboo stakes submerged in shallow seas.

normal analysis Groupings based on analysis of the attributes describing individuals—e.g. in plant ecology, the grouping of sample sites by analysis of their species composition. The term is particularly applied to numerical vegetation classification, and sometimes implies a plot, as distinct from species, classification. *See also* R-technique; *compare* inverse analysis; and Q-technique.

normalizing selection *See* maintenance evolution.

norte (norther) Cold, northerly, local wind affecting coasts of the Gulf of Mexico, most commonly in winter. Sometimes it brings rainfall.

North American giant threadfin (*Eleutheronema tetradactylus*) *See* Polynemidae.

North American lowland coniferous forest In contrast to the situation in Eurasia, N. America once possessed great tracts of lowland coniferous forest to the south of the boreal conifer zone. They comprised several formations, namely the lake forest, Pacific Coast forest, and the pine-barrens of the south-eastern USA. The lake forest has been all but destroyed.

North Atlantic Drift Oceanic surface current in the N. Atlantic, flowing from the Grand Banks off Newfoundland eastwards to NW Europe and

marking a northerly extension of the Gulf Stream. This diffuse, shallow and relatively warm current has an ameliorating influence on the climate of the coastal regions of NW Europe.

north-east African highland-and-steppe floral region Part of Good's (1974) African subkingdom, within his Palaeotropical kingdom. It contains about 50 endemic genera, although the island of Socotra accounts for nearly half of these despite the fact that it is not notably isolated. *Coffea arabica* is native to this region.

norther *See* norte.

'northern lights' *See* aurora.

northern mockingbird (*Mimus polyglottus*) *See Mimus*.

northern oriole (*Icterus galbula*) *See Icterus*.

northern viper *See Vipera berus*.

North Pacific current Oceanic surface current in the N. Pacific flowing eastwards, as an extension of the Kuroshio current, towards California. It occupies a position in the N. Pacific similar to that of the Gulf Stream and North Atlantic Drift system in the Atlantic.

Norway lobster *See Nephrops norvegicus*.

nor'wester Convective storm, usually from the north-west, which affects Assam and Bengal between March and May. It is characterized by violent conditions, including a line squall.

nosean Mineral, specific gravity 2.2–2.4, hardness 5.5, chemical composition $Na_8(AlSiO_4)_6SO_4$, which occurs in extrusive, alkaline, igneous rocks. It can be grey, white, or greenish, often with light-blue tinges, and has a vitreous lustre. It crystallizes in the cubic system. The crystals, when present, are rhombododecahedra, but it is also massive.

no-see-um *See* Ceratopogonidae.

nose-horned viper *See Vipera ammodytes*.

nose leaf In many Microchiroptera, a fleshy process on the face, sometimes large and of complex shape, concerned with the emission of sounds used in echo-location.

Nostoc (order Nostocales) Genus of filamentous cyanobacteria, in which the filaments have a distinctly beaded appearance under the microscope. The filaments aggregate to form distinct colonies. They are capable of nitrogen fixation. They are found in aquatic and terrestrial habitats. *Nostoc punctiliforme* occurs in symbiotic association with the plant *Gunnera*, living in the leaf bases where it fixes atmospheric nitrogen. *Nostoc* is also found as the phycobiont in certain lichens, e.g. the dog lichen *Peltigera canina*, and in lichen cephalodia. Some species of *Nostoc* are used as food in China and Japan.

Nostocales (division Cyanobacteria) Large order of filamentous cyanobacteria in which true branching of the filaments never occurs. Heterocysts and/or akinetes may be formed. Nostocales are found in a wide range of aquatic and terrestrial habitats.

Notacanthidae (spiny eel; class Osteichthyes, subclass Actinopterygii, order Notacanthiformes) Small family of deep-sea fish, which have a blunt snout and ventrally located mouth. The posterior half of the body tapers down to a narrow tail ending in a tiny tail-fin. Typically, there are at least six short and isolated dorsal spines on the back. The long-based anal fin also has short fin rays. Spiny eels such as *Notacanthus chemnitzii* (1.2 m) are bottom-living fish sometimes caught in trawl nets. There are about nine species, distributed worldwide.

Notacanthiformes Order of deep-sea fish of elongate, tapering form, terminating in a very small tail-fin. The pelvic fins are located on the abdomen slightly ahead of the origin of the dorsal fin. All species have a long anal fin and a ventrally positioned mouth. The order includes the spiny eels (Notacanthidae) and other deep-sea fish.

Notaspidea (Pleurobranchomorpha; phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods most of which have flat bodies and most of which are similar to slugs. There is no mantle cavity, and the shell is external or, if internal, reduced. One true gill is present. Most Notaspidea are grazing carnivores.

Noteridae (class Insecta, order Coleoptera) Family of shiny, aquatic beetles with paddle-like swimming legs, found in slow-moving water. Formerly they were placed in Dytiscidae, but they are distinguishable by their more flattened ventral surface and more convex dorsal surface. The larva has a long body, walking legs, and large, curved jaws, and taps air spaces of aquatic plants for oxygen. Adults and larvae prey on soft-bodied larvae and snails.

Notharchus (puffbirds; family Bucconidae) Genus of black and white puffbirds which have a black, or black and brown breast band. They inhabit forests and forest edges, and feed on insects and small vertebrates. One species nests in a tree-termite nest. There are four species, found in C. and S. America.

Nothofagus (southern beeches; family Fagaceae) Genus of evergreen or deciduous, big or small trees, in which the male inflorescences are sessile, or few-flowered, and the styles short. They are wind-pollinated. The fruits are subtended by valved spiny cupules. Antarctic beech is *N. antarctica*, which forms extensive low, impenetrable forests in S. Chile and Tierra del Fuego. There are 35 species of the southern hemisphere, occurring in the mountains of New Guinea, New Caledonia, Australasia, and temperate S. America.

Nothomyrmecia macrops (order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Nothomymeciinae) Probably the most primitive living ant, this species was known only from two workers collected in 1934, until a colony was discovered in S. Australia in 1977.

Nothosauria (nothosaurs) (Order Sauropterygia) Suborder of marine reptiles that flourished during the Triassic. They possessed long necks, and their limbs were adapted to swimming. *Nothosaurus* is one of several genera and one of the species referred to it was the last of the line. The nothosaurs were replaced by the plesiosaurs in the Early Jurassic.

Notobatrachus deguistoi Ancient representative of the frog family Ascaphidae, recorded from the Jurassic of Patagonia.

notochord (chorda dorsalis) Somewhat flexible, rod-like structure, composed on disc-like turgid cells, which extends virtually the entire length of the body of adult and/or larval members of the phylum Chordata. Lying below the nerve cord, but dorsal to the intestine, the notochord provides a form of flexible support to the body. In vertebrates the notochord is replaced wholly or partly by the vertebral column, but it is retained throughout life in Acania and Agnatha.

Notocrinacea (feather-stars; subclass Articulata, order Comatulida) Superfamily of feather-stars in which the centrodorsal cavity is narrow to moderate in size and surrounded by five radial pits. The cirrus sockets on the surface of the centrodorsal are large and numerous. The arms divide once only, at the second brachial ossicle. The superfamily is known from the Upper Cretaceous to Recent.

Notogea The Australian faunal region, which possesses a very distinctive fauna. It comprises Australia, New Guinea, Tasmania, New Zealand, and the islands to the south and east of Wallace's Line. It can be subdivided into the Australian region, the Polynesian region, and the Hawaiian region. *Compare* Arctogea; and Neogea, *see also* faunal region.

Notograptidae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of primarily marine fish which have an eel-like body, large eyes, a low-slung mouth, and rather reduced pelvic fins. The very long dorsal fin starts anterior to the pectoral fins. Both dorsal and anal fins are confluent with the tail-fin. Brightly coloured, *Notograptus guttatus* (13 cm) is found in the tropical waters of Australia and New Guinea. There are about three species, found in tropical Australia.

Notomyotina (starfish; subclass Asteroidea, order Paxillosida) Suborder of starfish, which bear long, flexible arms. The lower and upper rows of marginal plates alternate, and bear long, outwardly directed spines. The distal marginals imbricate with each other. The suborder is known from the Upper Cretaceous to Recent.

Notomys (jerboa-rat) *See* Muridae.

Notonectidae (backswimmers, water boatmen; order Hemiptera, suborder Heteroptera) Family of predatory, aquatic bugs, which swim in the water with their backs directed downwards, propelling themselves by means of the hair-fringed hind pair of legs; hence their common names. The front two pairs of legs are used to grasp prey. There are about 200 species, distributed worldwide.

notopodium In Polychaeta, the dorsal division of the parapodium.

Notopteridae (featherback, knifefish; class Osteichthyes, subclass Actinopterygii, order Osteoglossiformes) Small family of freshwater fish, which can be distinguished by the small, feather-like dorsal fin half-way along the back, and by a very long anal fin starting near the pectoral fin base and merging with the small tail-fin at the end of the tapering body. *Notopterus chitala* (banded knifefish), 1 m, is of importance as a food fish in parts of SE Asia. As with other members of the family, its aggressiveness does not make it a good aquarium fish. There are about six species found in SE Asia and Africa.

Notoryctidae (marsupial mole; order Marsupialia, superfamily Dasyuroidea) Family of small, burrowing marsupials, in which the eyes are much reduced, there are no external ears, the cervical vertebrae are fused, and the strong forelimbs bear large, triangular claws on the third and fourth digits. The teeth are well separated, and often blunt. They are found in parts of S. and NW Australia. There is one genus, *Notoryctes*, and one species.

Notorynchus maculatus (sevengill shark) *See* Hexanchidae.

Notostraca (tadpole shrimps; phylum Arthropoda, subphylum Crustacea, class Branchiopoda) Order of branchiopod Crustacea, with the head and anterior trunk enveloped by a large, shield-like carapace. The first antennae are absent, and the second pair are vestigial. The sessile compound eyes are close together beneath the dorsum of the carapace. The highly flexible abdomen bears up to 70 paired appendages, and culminates in a pair of long processes, or caudal furcae. Tadpole shrimps inhabit temporary pools in desert areas, and their resistant eggs may survive 20 years or more of being blown about in desert dusts. There are 15 species.

Notosudidae *See* Scopelosauridae.

Nototheniidae (cod icefish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, most species of which have an elongate body, a large head, a short first dorsal fin; the second dorsal and anal fins are long. Nototheniidae form the most numerous group of antarctic fish, adapted to a life in extremely cold sea-water. In some species the blood lacks red blood cells. *Notothenia coriiceps* (60 cm) feeds on a variety of bottom-dwelling invertebrates. *Pleurogramma antarcticus* (20 cm) is a pelagic species, dominant among antarctic mid-water fish. There are about 59 species, found in coastal Antarctica and S. America.

Notoungulata (cohort Ferungulata, superorder Protoungulata) Extinct order of ungulates. Apart from one Lower Eocene representative from N. America and a well-established representative from the late Palaeocene of E. Asia, they are exclusively S. American. They flourished on that continent during the Oligocene and survived to the Pleistocene, evolving into many forms. Their dentition was complete and the tympanic bulla was large, the structure of the ear being different from all other mammals. They were mesaxonic, many of them possessing only three digits. Some had claws, but others appear to have possessed hoofs, though none achieved an unguligrade gait. Some later forms became large. *Toxodon*, which may have been the most common large ungulate during the S. American Pleistocene, was about 2.75 m long, had a massive head, and hind legs that were much

longer than the forelegs. In life it may have looked like a very large guinea pig. In addition there were the homalodotheres, which resembled the perissodactyl chalicotheres (the so-called 'clawed horses'), and a range of large and small rodent-like animals referred to as hypotheres.

Notoxaea *See* Oxaeidae.

NPP (P_n) Net primary production. *See* primary productivity.

nucellus *See* ovule.

Nucifraga (nutcrackers; family Corvidae) Genus of medium-sized crows which have long, stout bills, and white-spotted, brown, or grey and black plumage. They inhabit coniferous forest, feed on conifer seeds, nuts, and insects, and nest in trees. There are two species, found in Europe, Asia, and N. America.

nuclear envelope (nuclear membrane) The structure that separates the nucleus of eukaryotic cells from the cytoplasm. It comprises two unit membranes each 10 nm thick, separated by a perinuclear space of 10–40 nm. At intervals, the two membranes are fused around the edges of circular pores which allow for the selective passage of materials into and out of the nucleus.

nuclear membrane *See* nuclear envelope.

nuclear-pore complex Complex formed from the nuclear pore of a eukaryotic cell and the granular or fibrous annular material with which it is filled. The structure of the filling material, in particular, is still ill-defined, though it is thought to be a hollow cylinder. Its function is equally obscure, though probably it is concerned with regulating the transport of materials through the pores.

nucleic acids Nucleotide polymers, with high relative molecular mass, produced by living cells and found both in the nucleus and cytoplasm. They occur in two forms, designated DNA and RNA, and may be double- or single-stranded. DNA embodies the genetic code of a cell or organelle, while various forms of RNA function in the transcriptional and translational aspects of protein synthesis.

nucleoid One of a number of names given to the area of a prokaryotic cell that contains the chromosomal DNA.

nucleolus A clearly defined, often spherical area of the eukaryotic nucleus, composed of densely packed fibrils and granules. Its composition is similar to that of chromatin, except that it is very rich in RNA and protein. It is the site of origin of ribosomes.

nucleoprotein Conjugated protein, composed of a histone or protamine bound to a nucleic acid as the non-protein portion.

nucleoside Glycoside, composed of ribose or deoxyribose sugar bound to a purine or pyrimidine base.

nucleosome Particle, approximately 10 nm in diameter, found in large numbers in isolated chromatin.

nucleotide Nucleoside bound to a phosphate group, through one of the hydroxyl groups of the sugar. It is the unit structure of nucleic acids.

nucleus 1 The double-membrane-bound organelle containing the chromosomes that is found in most non-dividing eukaryotic cells: it is essential to their long-term survival. It is variously shaped, although it is normally spherical or ovoid. It disappears temporarily during cell division. It is absent from viruses. The chromosomes, though probably intact, are not visible when the cell is in a resting stage (i.e. not dividing). The nucleus also contains nucleoli, small spherical dense bodies made up of ribosomal RNA and protein, which gives it its integrity. 2 A small, solid particle, e.g. of dust, salt or smoke. Such particles are 'condensation nuclei' whose hygroscopic properties encourage condensation, often in unsaturated air. Other nuclei, e.g. some clay particles such as kaolinite, probably act as 'freezing nuclei' in the initial stage of ice-crystal formation. *See also* Aitken nucleus; Bergeron–Findeisen theory; condensation nucleus; and ice nucleus.

Nuculoida (class Pelecypoda, subclass Palaeotaxodonta) Order of pelecypods, which have a taxodont hinge, and equivalve, aragonitic shells. They are isomyarian, the ligament generally amphidetic, and the gills are protobranchiate. The foot is grooved. Adults lack a byssus. Nuculoids are small, infaunal, labial-palp feeders, which first appeared in the Ordovician.

Nuda (Macropharyngea; phylum Ctenophora) Class of ctenophorids which lack tentacles. There is only one order, Beroidea.

nudation Initiation of a new plant succession by a major environmental disturbance, e.g. a volcanic eruption.

nuée ardente *See* ignimbrite.

null allele *See* silent allele.

null hypothesis *See* hypothesis.

numbat (*Myrmecobius fasciatus*) *See* Myrmecobiidae.

numbfish *See* Torpedinidae.

Numenius (curlews, whimbrel; family Scolopacidae) Genus of medium- to large-sized, brown wading birds which have very long to medium-length, decurved bills, and long legs. They breed in arctic tundra and grassland, wintering on coastal estuaries. They feed on invertebrates, and nest on the ground. *N. borealis* (eskimo curlew) is close to extinction. There are eight, migratory species, found worldwide.

Numenius borealis (eskimo curlew) *See Numenius*.

numerical method (numerical taxonomy) Any numerical description of an individual or community, or comparisons of these (such as similarity indices), or data-structuring methods (such as principal-components analysis and classification). The essential point is that numerical methods make no assumptions about the data, e.g. the sampling approach used, the distribution of the data, or the

probability of particular patterns or frequencies. In contrast, statistical methods do make certain assumptions about the form of the data, on which the validity of significance testing depends. *Compare* statistical method.

numerical taxonomy *See* numerical method.

Numida meleagris (helmeted guineafowl) *See* Numididae.

Numididae (guineafowl; order Galliformes) Family of grey or black fowl, mostly spotted white, which have bare heads, some with wattles or a crest. They have rounded wings, medium-length tails, and strong legs and feet, some with spurs. They inhabit forest and brush, feed on insects and seeds, and nest on the ground. There are five genera, comprising seven species, found in Africa. *Numida meleagris* (helmeted guineafowl) has been widely domesticated.

Nummulites fichteli The last representative of the nummulites, which is recorded from the Middle Oligocene.

Nummulites globulus Earliest representative of one of the most important groups of fossil protozoans. The nummulites deposited a many-chambered, disc-like, calcareous shell, and a rapid speciation makes individual species useful zone fossils. *N. globulis* is known from the mid-Palaeocene.

nunatak Rocky summit or mountain range that stands above a surrounding ice sheet in an area that currently is being glaciated.

nun babblers *See Alcippe*.

nuptial pad In Ranidae (frogs), one of the horny or thickened pads on each thumb of the male. They are especially prominent during the mating season, when they assist the male to grasp the female during the sexual embrace, in which the male extrudes sperm over the eggs as these are ejected by the female.

nursery fish *See* Kurtidae.

nursery-web spiders *See* Pisauridae.

nurse shark *See* Orectolobidae.

nut A dry, indehiscent, woody fruit.

nutcrackers *See Nucifraga*.

nuthatches 1 *See Sitta*; and Sittidae. 2 (coral-billed nuthatch, *Hypositta corallirostris*) *See* Hypositidae.

nutlet A little nut, as in Labiatae.

nutmeg Seed of *Myristica fragrans*. *See Myristica*.

nutmeg tree *See Torreya*.

nutrient cycle *See* biogeochemical cycle.

Nuytsia (family Loranthaceae) Genus of small, bushy-crowned trees which are root parasites, at least when young. The flowers are vivid orange. There is one species, confined to W. Australia.

nyatoh *See Palaquium*; *Payena*; and *Planchonella*.

Nyctaginaceae (bougainvilleas) Family of herbs, shrubs, and trees with opposite or alternate simple leaves with no stipules. The inflorescence is cymose, with bisexual or unisexual flowers sometimes surrounded by coloured bracts resembling a calyx. The sepals are petal-like and tubular. There are no petals; usually five stamens alternate with the lobes of the calyx. The ovary is superior with a single carpel, a single ovule, and a long style. The fruit is an achene, sometimes enclosed by the persistent calyx. The seeds contain endosperm, perisperm, and embryo. Several *Bougainvillea* species are used as hedging plants in warm-temperate regions, and many of the species of the family are cultivated as ornamentals. Several species are used in medicine, e.g. *Mirabilis jalapa*, which gives a purgative drug. There are 30 genera, comprising about 290 species. They are found throughout the tropical regions of the world, but more than 200 of the species are centred in America.

Nycterentes procyonoides (raccoon dog) *See* Canidae.

Nycteribiidae (class Insecta, order Diptera, suborder Cyclorrapha) Small family of highly modified flies, which are ectoparasites of bats. Adults have the head folded back, to rest in a groove on the thorax. The antennae are two-segmented, and have a terminal arista. They have a fan-shaped, eversible comb of spines (the ctenidium) on the front of the thorax. Wings are absent, and the legs are long and adapted for clinging. Larvae are produced in a mature state, and form puparia after falling from the host bat. There are more than 200 species, occurring most commonly in Asia, Europe, and Africa.

Nycteridae (slit-faced bats; order Chiroptera, suborder Microchiroptera) Family of bats, in which the face is marked by a slit from the nose to between the eyes, formed from a nose leaf composed of fleshy pads. The ears are very large and separate; the uropatagium is large, supported by long calcars and by the tail which extends to its edge where it ends in a T-shaped vertebra. The body is covered in long, loose fur. The bats are distributed through tropical and subtropical Africa, W. Arabia, and part of the Mediterranean region, and in Malaysia and Indonesia. There is one genus, *Nycteris*, with about ten species.

Nyctibiidae (pottoos; order Caprimulgiformes) Family of grey, brown, and black, cryptically coloured birds which have long wings and tails. They have small bills, large gapes, and no rictal bristles. They are nocturnal, inhabit open forest, feed on insects, and nest in tree crevices. There is one genus, *Nyctibius*, with five species, found in C. and S. America.

Nyctibius (pottoos) *See* Nyctibiidae.

Nycticorax (night herons; family Ardeidae) Genus of medium-sized herons, which have fairly short necks and legs. They are grey or brown with a black cap or face and head plumes, and a stout bill. They are nocturnal, feed on fish and amphibians, and nest in a tree or bush. There are three species, found worldwide.

nymph 1 Crescent-shaped platform, present in certain pelecypods, to which the ligament is attached. 2 *See* larva.

Nymphaea (waterlilies; family Nymphaeaceaé) Genus of perennial aquatic plants, found in shallow water, with large rhizomes, and peltate or cordate, usually floating leaves. The flowers are solitary, with green or coloured sepals, and three to many petals. The ovary is half-inferior, and the seeds have an aril. The flowers are often pollinated by beetles. Many species are cultivated, and the seeds and rhizomes can be eaten. There are 50 species, found in temperate and tropical regions of the world.

Nymphaeaceae (waterlilies) Family of aquatic herbs with large, rounded, floating leaves on long stalks, attached to rhizomes rooted on the bottom of the river or lake. The flowers are large and solitary, with 3–6 green sepals; three to numerous petals; numerous stamens; and many carpels, which are usually joined into a many-celled superior ovary of flask-shaped or globose form. There are some six genera, with 60 species, found throughout tropical and temperate areas of the world.

Nymphalidae (admirals, brush-footed butterflies, duffers, emperors, fawns, fritillaries, map butterflies, rajah butterflies, saturn butterflies, vanessas; order Lepidoptera) Family of small to large, colourful butterflies. The forelegs are reduced, non-functional, and with long, hair-like scales. The egg is ribbed, the larvae are spined, and the pupae are not supported by a silken girdle. There are about 5000 species. The family has a worldwide distribution.

Nymphoides (fringed waterlily) *See* Menyanthaceae.

Nypa (family Palmae) Monotypic genus of palms, which is one of the oldest fossil flowering plants. It has an underground, dichotomously branched, horizontal rhizome, erect tufts; and big pinnate leaves, useful for thatch. The inflorescences are erect, with separate, clustered, male and female flowers. There are three carpels. The fruits are angular nuts held in big, globose heads. Sugar or toddy is obtainable from the sap. *M. fruticans* inhabits mangrove swamps from Bangladesh to the Solomon and Mariana Islands, with fossils in Africa and America.

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oak 1 *See Quercus*. 2 (African oaks) *See* Ochnaceae.

oak apple gall (King Charles's apple) Gall formed by the agamic (unisexual) generation of the wasp *Biorrhiza pallida* (family Cynipidae). Apterous, agamic females arise from root galls of *Quercus robur* and climb the trunk of the tree in spring to lay many eggs in the bases of leaf buds. These eggs cause the formation of the familiar multilocular, pale pink, spongy galls that have the appearance of small apples. The galls mature by mid summer, and give rise to the sexual generation whose males and females emerge in June to July and mate. Mated females penetrate the soil around the oak tree and lay eggs on rootlets, giving rise to small, brown, rounded galls whose occupants emerge at the end of their second winter. May 29 is Oak Apple Day, and commemorates the restoration of the English monarchy in 1660 (and the birthday of Charles II). *See also* Cynipinae.

oak marble gall Dark brown, hard, spherical gall on *Quercus robur*, formed by the sexual generation of the gall wasp *Andricus kollari* (family Cynipidae). Oak marble galls contain the agamic-generation females which emerge in the spring to form the remarkable 'ant-pupae' galls on the axillary buds of *Quercus cerris* (Turkey oak). The insect was introduced to Britain in 1830 for use in the dyeing and ink industry, the marble galls containing up to 17% dry weight of tannic acid. *See also* Cynipinae.

oakmoss Common name for the lichen *Evernia prunastri*. The thallus consists of flattened, strap-like branches which are greenish-grey on the upper surface and white beneath. Whitish, powdery soredia are often present. Oakmoss is common in areas of relatively low air pollution, on a range of substrates: trees, fences, rocks, walls, etc. It is extensively used in the perfume industry as a fixative and as a scent component. *Compare Pseudevernia*.

oak-nut General common name applied to any gall which forms on an oak tree.

oak spangle gall Generic term for the agamic-stage galls of *Neuroterus* species of wasps (family Cynipidae) found on the leaves of *Quercus robur*. There are four species: *N. tricolor*, *N. quercus-baccarum*, *N. numismalis*, and *N. albipes*. The eggs laid by mated females of the sexual generation give rise to generally small (1 mm diameter), flat, red galls. Gall densities may be high, but competition appears to be avoided by niche separation within a single leaf and within a host tree, some species preferring leaf margins or apices, others favouring the peripheral foliage. Spangle galls overwinter in the leaf litter, often having become separated from the leaves. *See also* Cynipinae.

oarfish *See* Regalecidae.

oarweed Either any seaweed of the genus *Laminaria* or, more specifically, *L. hyperborea*. *L. hyperborea* is a large seaweed with fronds which can measure up to 3.5 m long. The stipe is stiff, tapers towards the top, and has a rough-textured surface which provides a suitable substrate for many epiphytic seaweeds. The blade is divided into a number of strap-like ribbons and is oar-shaped in outline. The holdfast consists of numerous thick, root-like branches. It is found just below low-water mark, attached to rocks.

obduction The displacement upwards and horizontally of a lithospheric plate at a destructive-plate boundary. It is the opposite of subduction.

obeche *See Triplochiton scleroxylon*.

obligate parasite *See* parasitism.

Obolellida (class Inarticulata) Order of brachiopods with calcareous, biconvex, subcircular to oval shells. This extinct group is known only from the Lower and Middle Cambrian. Its members were widely distributed and locally abundant in the Lower Cambrian, where they are among the earliest known elements of brachiopod faunas.

obovate *See Duboisia*.

obsequent Applied to a land-form whose orientation is opposite to that which may have been expected. For example, an obsequent stream flows against the dip of underlying strata; and an obsequent fault-line scarp faces the opposite way to the original fault scarp.

obtect Applied to the pupae of those endopterygote insects in which the appendages adhere to the body by means of a secretion produced at the last larval moult. Obtect pupae are found in some Coleoptera, many chalcidoid wasps, and in all nematoceran Diptera and higher Lepidoptera.

obturata foramen In the pelvis of mammals, a large opening between the pubis and ischium.

occipital condyle At the back of the skull, a bony knob which articulates with the first vertebra. It is absent in fish, and double in amphibians and mammals.

occluded front The composite front formed when a warm front and the sector of warm air behind it is overtaken by a cold front. *See also* occlusion.

occlusal Applied to the grinding or biting surfaces of a tooth.

occlusion Stage in the development of a frontal depression during which the warm-sector air is gradually lifted from the ground and above the colder air. The word is used to describe an occluded front. An occlusion may be a 'warm occlusion' such that warmer air follows the frontal system, or a 'cold occlusion', such that colder air follows in the

rear. A 'warm occlusion' has characteristics similar to those of a warm front, but there is an upper cold front ahead and aloft which brings showers from cumulus and cumulonimbus cloud. A 'cold occlusion' exhibits cold-front features, but is preceded by warm-front cloud types. Occlusions formed in the later stages in the development of travelling depressions commonly cross NW Europe, especially the 'warm' type in winter and the 'cold' type in summer.

ocean Salt water mass that occupies more than two-thirds of the surface of the Earth (70.8%). In terms of volume the oceans contain 1370 million km^3 of water; the average depth is 3730 m.

ocean-basin floor The part of the floor of those parts of the oceans that are deeper than 2000 m below sea-level. It occupies approximately one-third of the Atlantic and Indian Ocean floors and three-quarters of the Pacific Ocean floor.

ocean current Large-scale water movement in an ocean, arising from three main causes: (a) wind stresses acting on the surface of the sea; (b) tidal motion caused by the variable attraction of the Sun and Moon; and (c) density differences in sea-water caused by differential heating and cooling, salinity differences, or variations in the suspended-sediment concentration of sea-water masses.

oceanicity The effects of maritime influences on a climate. *See also* continentality.

oceanic plateau Extensive, topographically high area of an ocean floor that rises to within 2–3 km of the sea surface above the abyssal floor, e.g. Iceland, the Galápagos Islands platform, and the Azores platform. Many Pacific plateaux, e.g. the Magellan Rise and Ontong Java Plateau, have a thick covering of carbonate oozes overlying volcanic rocks. The origin of such plateaux is volcanic, but many are now inactive.

oceanic province *See* oceanic region.

oceanic region (oceanic province) The area of open ocean beyond the continental shelf.

Oceanites (storm petrels; family Hydrobatidae) Genus of small to medium-sized petrels, which have short wings, long legs, and yellow, webbed feet. They are mainly sooty-brown with a white rump. They inhabit southern oceans, but also occur north of the equator, following ships. They breed on sub-antarctic islands. There are two species, *O. oceanicus* (Wilson's petrel) occurring in the N. Atlantic.

Oceanites oceanicus (Wilson's petrel) *See Oceanites.*

Oceanitidae (storm petrels; order Procellariiformes) Alternative name for the Hydrobatidae.

Oceanodroma (storm petrels; family Hydrobatidae) Genus of medium-sized, long-winged petrels, which have forked tails and short legs. They are mainly sooty-brown, some with white rumps, some grey with white under-parts. They are swift fliers, rarely following ships. They breed in burrows and rock crevices on islands. There are 11 species, found mainly in northern oceans.

ocean perch (*Sebastes marinus*) *See* Scorpaenidae.

ocean pout (*Macrozoarces americanus*) *See* Zoarcidae.

ocean wave Disturbance of the ocean's surface, seen as an alternate rise and fall of the surface. Ocean waves are of several types: (a) wind-generated waves, e.g. sea waves (chaotic wave pattern) and swell (long-period waves); (b) catastrophic waves, e.g. tsunamis, landslide surges, and storm surges; and (c) internal waves (subsurface waves at the boundary between two distinct water layers).

ocean whitefish (*Caulolatilus princeps*) *See* Malacanthidae.

ocellated lizard *See Lacerta lepida.*

ocellus (pl. ocelli) A simple eye, which has a single, thickened, cuticular lens. The epithelial cells below the lens are transparent, and below them there are many light-sensitive nerve cells. *See also* eye.

Ochnaceae Family of trees, shrubs, and herbs, with simple, alternate leaves with stipules. The regular, bisexual flowers are held in panicles, racemes, or umbels. The calyx is either united at the base or free. The corolla has five twisted or convoluted petals. There are five or more stamens. The ovary is superior with several carpels, which although not usually united have a common style. The fruit is a cluster of drupes, a berry, or a capsule. The seed often contains endosperm. The family is closely related to the Dipterocarpaceae and includes a few species of commercial timber trees known as the African oaks (*Lophira* species). There are 40 genera, comprising about 600 species, found throughout the tropics but concentrated in S. America.

Ochotonidae (calling hares, conies, mouse hares, pikas; cohort Glires, order Lagomorpha) Family of lagomorphs in which the ears are short, the tail is not visible externally, and the hind limbs, bearing four digits, are only slightly longer than the forelimbs, which bear five digits. Ochotonidae live in mountainous regions throughout the northern hemisphere at altitudes higher than those available to most mammals. They shelter in burrows or crevices, some socially, and do not hibernate, feeding during winter on plant material that they have gathered and dried during the summer and autumn. There is one genus, *Ochotona*, with about 14 species.

ochrea *See* Polygonaceae.

Ochrolechia (family Pertusariaceae) Genus of lichens in which the thallus is crustose. The apothecia are lecanorine. The spores are large, colourless, and aseptate. There are many species, found on trees, rocks, walls, etc. Some species were formerly used for dyeing cloth.

Ochromonas (class Chrysophyceae) Genus of single-celled algae in which the cells are pointed at the anterior end and blunt at the posterior end; there are one or two brown chloroplasts, and two flagella—a long, forward-pointing, tinsel flagellum, and a shorter, backward-pointing, whiplash flagellum. The genus has been used experimentally in

studies on algal nutrition; although normally photosynthetic, the cells can also take in food phagotrophically and require organic nutrients to survive. They are found in puddles, ponds, lakes, etc., especially in spring.

Ocotea (family Lauraceae) Genus of trees, which includes *O. rodiaei* (greenheart). It and others are valuable for their heavy, hard, durable timber. There are 400 species, occurring in the tropics, mainly in America, but a few in Africa.

ocrea *See* Polygonaceae.

octahedrite *See* anatase.

octocoral *See* Octocorallia.

Octocorallia (class Anthozoa) Subclass of sedentary, colonial corals with polyps always bearing eight tentacles, almost invariably pinnate. There are eight complete, unpaired mesenteries and septa; and there is a ventral groove on the stomodaeum. Skeletal structures are usually made from calcareous spicules.

Octodontidae (bush rats, hedge rats, degus; order Rodentia, suborder Hystricomorpha) Family of rat-like, ground-dwelling or burrowing rodents in which the tail is haired, the hairs growing longer closer to the tip and ending in a tuft. The limbs are short, the forelimb having five digits and the hind limb four. The hind digits have bristles which extend stiffly beyond the claws. Octodonts are confined to the west coast of S. America. There are five genera, with about seven species.

Octomeles (family Datiscaceae) Genus of one species (*O. sumatrana*), a huge, very fast-growing tree with leaves that are palmately nerved. It yields useful timber (binuang). It occurs from most parts of the Malay peninsula to the Solomon Islands.

octoploidy *See* polyploidy.

Octopoda (octopuses, devilfish; class Cephalopoda, subclass Coleoidea) Order of cephalopods which have eight long arms possessing suckers, and a round, sack-like body. A few have a much reduced, internal shell. Probably they arose from a belemnite forebear, some time in the early Cretaceous. Since they lack hard parts they have a poor fossil record.

octopuses *See* Octopoda.

ocular point *See* Haematopinidae.

Odacidae (rock whiting; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish with an elongate body, long dorsal fin, and straight-edged tail-fin. The teeth are fused together and thus resemble those of the Scaridae (parrotfish). Generally colourful fish, they tend to live in weedy patches in relatively shallow water. *Haletta semifasciata* (blue rock whiting), which grows to 40 cm, is fairly common in temperate Australian waters. There are about eight species, found in the cooler waters of Australia and New Zealand.

Odobenidae (walruses; order Carnivora, suborder Pinnipedia) Family of marine carnivores known since the Miocene and related to the Otariidae. There are no external ears or tail, and the hind limbs are brought forward beneath the body when the animal is on land. The upper canines form large tusks in both sexes but the remaining teeth are small and often lost, leaving only the heavy, peg-like molars for crushing. Walruses feed exclusively on shellfish. They are found around the margins of the Arctic Ocean, in shallow waters and on ice floes. There is one genus and one species only, *Odobenus rosmarus*.

Odonata (damselflies, devil's darning needles, dragonflies, horse-stingers; class Insecta) Order of primitive insects, the earliest fossils of which are found in the Upper Carboniferous coal measures of Commentry (France). These slender-bodied insects have two pairs of large, glassy wings, and large, prominent eyes. They usually hunt on the wing, taking swarming dipterans and other flying insects. Odonates are unique in possessing two sets of genitalia (*see* accessory genitalia). The nymphs are aquatic, and catch prey with a prehensile organ (called the mask) derived from the labia. Despite their fearsome common names, these beautiful insects are not dangerous to large animals. About 5000 species are known, with a cosmopolitan but mainly tropical distribution.

Odontaspididae (Carchariidae; grey nurse shark, sand tiger; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Small family of large sharks, characterized by having all the gill slits in front of the pectoral fin; sharp, non-serrated teeth; and two dorsal fins equal in size to the anal fin. The fearsome *Odontaspis taurus* (grey nurse shark), growing to 5 m in length, is common along Australian and S. African beaches, but may be less dangerous than is often claimed. There are possibly seven species, distributed worldwide.

Odontaspis taurus (grey nurse shark) *See* Odontaspididae.

Odontoceti (toothed whales; cohort Mutica, order Cetacea) Suborder of marine mammals comprising the ancestral forms, known from the Upper Eocene, and the four superfamilies: Squalodontoidea (extinct forms), Platanistoidea (river dolphins), Physeteroidea (large whales), and Delphinoidea (smaller whales, dolphins, and porpoises). Teeth are always present, and may be numerous (e.g. squalodonts which possessed up to 180 teeth, one porpoise which had 300, and the river porpoise *Platanista* which has more than 50), or reduced to two teeth (*Monoceros*). The teeth are simple and peg-like and are not differentiated into incisors, canines, etc. There is a single nasal opening and the nasal bones do not form part of the roof of the nasal passage.

odontoid process Peg-like bony process projecting forward from the second (axis) vertebra into the first (atlas) vertebra, but formed from the centrum of the atlas which has become detached and fused to the axis.

Odontophorus (wood quails; family Phasianidae) Genus of medium-sized game birds, which are mainly brown, speckled and barred with black, with the head and throat often patterned with black and white. The head has long crown feathers. They

have short, stout bills, and large, strong legs and feet. They inhabit forests; feed on seeds, fruit, and insects; and nest on the ground. There are 14 species, found in C. and S. America.

Odontostomatida (subclass Spirotrichia) Order of ciliate protozoa whose cells are compressed and wedge-shaped. Body cilia are usually confined to several rows at each end. There are two families, with several genera, found in freshwater habitats that contain organic material and that are deficient in oxygen.

Oeciacus hirundinis (martin bug; order Hemiptera, family Cimicidae) Bug, related to *Cimex lectularius* (bedbug), which lives in the nests of house martins and sometimes of other birds, feeding on the blood of the occupants. When its hosts have migrated to winter quarters it may enter houses and cause annoyance by biting humans.

Oecophylla leakeyi Species of weaver ant whose early Miocene remains, from Mfwangano Island (L. Victoria), illustrate the early development of ant society. Remains of 366 ants were discovered in one spot, with castes well differentiated and represented in the same proportions as in modern representatives of the genus. Larvae and pupae were discovered; and some workers were still attached to modern leaf fragments. Other *Oecophylla* species, preserved in amber, are known from the Oligocene of N. Europe, but none in a colony deposit like the *O. leakeyi* discovery. At the present time species of *Oecophylla* live in Africa and tropical Asia.

Oecophylla longinoda (weaver ant; order Hymenoptera, suborder Apocrita, family Formicidae, subfamily Formicinae) Species of large, red, African ants whose nest is constructed from the living leaves of a tree, held together by silk produced by larvae.

Oedemera nobilis (thick-legged beetle) *See* Oedemeridae.

Oedemeridae (class Insecta, order Coleoptera) Family of soft-bodied, parallel-sided, finely pubescent beetles, 5–18 mm long, in which the elytra may not fully cover the abdomen. They resemble Cantharidae, but the head is more produced in front of the eyes, the pronotum much narrower, and the filiform antennae longer. Some species are toxic. Oedemeridae are found feeding at flowers, particularly on the coast. Larvae are found in old wood, preferring wood that is waterlogged. The male of *Oedemera nobilis* (the thick-legged beetle) is brilliant metallic green, with large, swollen, hind femora. There are 1500 species.

Oedogoniales (class Chlorophyceae) Order of filamentous green algae in which each cell has a single nucleus. Reproductive cells are motile, having a whorl of flagella at one end. Cell division occurs by a unique mechanism. There are three genera, found in ponds, lakes, etc.

Oegophiurida (class Stelleroidea, subclass Ophiuroidea) Order of primitive ophiuroids in which dorsal and ventral arm-plates are lacking, as are large plates of the disc (radial shields, etc.). The body cavity, containing gonads and digestive organs, extends into the base of the arms. The order was most abundant in the Palaeozoic, but is known from the Ordovician to the Recent, and there is one extant genus, *Ophiocanops*.

Oenanthe **1** (wheatears; family Turdidae) Genus of black, grey, or brown and white birds, most of which have distinctive white rumps, and black tails. They inhabit open, rocky, and grassy areas, feed on insects, and nest on the ground in crevices and burrows. There are 18 species, many migratory, found in Europe, Africa, Asia, and N. America. **2** (water-dropworts; family Umbelliferae) Genus of herbs, some of which are very poisonous, distributed widely in temperate regions.

Oenothera (evening primrose; family Onagraceae) Genus of flowering plants with spirally arranged leaves, and four-petalled, large, usually yellow to orange flowers in a leafy spike. The seeds, unlike those of some other genera in the family, are not plumed. The unusual chromosome morphology and genetic mechanism of *Oenothera* have been the subject of much study by cytogeneticists. There are about 100 species, native to N. America, but some are much cultivated in gardens for the flowers, both as species and as hybrids, and are now well naturalized in Europe and elsewhere.

oesophagus The part of the alimentary canal that lies between the pharynx and the stomach.

Oestridae (warble flies, bot flies; class Insecta, order Diptera, suborder Cyclorrapha) Small family of stout, hairy flies, which are often bee-like. Their antennae are short, and partially sunken into facial grooves. The wing vein M_1 is bent forward, and the postscutellum is distinct. The oviscapt of the female is long and extensible, to enable eggs to be laid in enclosed sites on the body hairs of mammals. The larvae are found beneath the skin of large mammals, feeding on exudations from the host tissues. The larvae of *Hypoderma* species (warble flies) form swellings ('warbles') on either side of the spine of their host after migrating through the subdermal tissues. The mature larvae bore through the hide of the host before pupating on the ground. They cause much financial damage to hides which it is planned to convert to leather products. The sheep-nostril fly, or bot fly, is larviparous, the young larvae being deposited in the nostrils of sheep, from where they migrate to the sinuses. In N. and S. America *Dermatobia hominis* (human warble fly) uses mosquito or muscid flies as carriers of its eggs to humans. The eggs hatch in response to the body heat of the host, and the larvae bore into the skin, causing a 'warble'. So far 60 species have been recognized. *See also* venation.

oestrogen (estrogen) Generic term for a group of C_{18} steroids that act as female sex hormones, having a wide range of physiological effects. The major oestrogens are oestrone and beta-oestradiol.

offal Refuse; waste. In forestry, the term is applied to the waste from squared timber, and to lop, top, and branches.

offshore bar *See* bar.

offshore zone Zone extending seaward from the point of low tide to the depth of wave-base level or to the outer edge of the continental shelf.

Ogcocephalidae (batfish; class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Family of bizarre, marine, bottom-dwelling fish. The body is usually much depressed and flattened sideways, with the eyes located on the upper surface. Awkward swimmers, the batfish use the widely separated pectoral fins as legs to 'walk' over the bottom of the sea-bed. Often partly hidden in the sand, batfish use a long tentacle on the head to entice small fish to come close by, and then swallow them. The brownish *Ogcocephalus vespertilio* (long-nosed batfish) is one of the more common species of the Atlantic region. There are about 55 species, distributed worldwide.

Ogcocephalus vespertilio (long-nosed batfish) *See* Ogcocephalidae.

ogive Banded pattern on the surface of a glacier. Normally it is convex down-glacier due to relatively high velocities at the centre. The banding effect may be due to alternating bands of white ice (containing many air bubbles) and dark ice (few air bubbles), or to variations in longitudinal pressure.

-oidea Recommended, but not mandatory, suffix used to indicate a superfamily of animals, e.g. Chelonoidea, the sea turtles.

oidium (mycol.) Thin-walled cell formed by the fragmentation of a hypha, and capable of functioning as a gamete, or of germinating to form a new hypha.

oil (petroleum) In geology, a term used generally to describe naturally occurring liquid hydrocarbons formed by the anaerobic decay of organic matter. Oil is rarely found at its original site of formation, but migrates to a suitable structural or lithological trap. Oil is frequently associated with salt water and with gaseous hydrocarbons.

oil beetle *See* Meloidae.

oilbird (*Steatornis caripensis*) *See* Steatornithidae; and Caprimulgiformes.

oil palm *See Elaeis*.

oil shale *See* shale.

okapi (*Okapia*) *See* Giraffidae.

okra *See Hibiscus*.

okta *See* cloud amount.

Olacaceae Family of shrubs, trees, and climbers, whose members have alternate, simple leaves without stipules and with a rough texture. The flowers are green or white, and regular, with the calyx reduced to narrow lobes. The petals lie closely together, but do not overlap, and are of the same number as the calyx lobes, usually 4–6. There may be up to twice as many stamens. The ovary is half inferior, with 1–3 uni-ovular locules. There is a single style with a lobed stigma. The fruit is a single-seeded nut or drupe. The seed contains a copious endosperm. The family includes several timber trees, and some with edible fruits, e.g. *Heisteria* species, which yield a hard timber, used in building; and *Coula edulis* (African walnut), yields edible fruits as well as timber used in building. The family consists of 25 genera, with 250 species, found throughout the tropics, but with the largest number of species in Africa and Asia.

old-field ecosystem Ecosystem that develops on abandoned farmland. The term is most commonly used in the USA.

Old Red Sandstone The continental facies of the Devonian in the British Isles. It is characterized by red sandstones and conglomerates which were deposited under terrestrial conditions.

old wife (*Enoplosus armatus*) *See* Enoplosidae.

old wives' summer *See* singularity.

Old World carpenter bee (*Xylocopa*) *See* acarinum.

Old World flycatchers *See* Muscicapidae.

Old World monkeys *See* Cercopithecidae.

Old World orioles *See* Oriolidae; and *Oriolus*.

Old World vultures *See* Accipitridae.

Old World warblers *See Sylvia*; and Sylviidae.

Olea (olive; family Oleaceae) Genus of trees and shrubs, in which the leaves are usually grey-green and elliptical or linear, and the fruits are berries rich in oil. They are widely distributed in the Old World. *O. europaea* (common olive) is much cultivated in Mediterranean climates for its fruits, for eating, and for olive-oil production, but its native home is probably further east than the Mediterranean shores.

Oleaceae Family of trees or shrubs with opposite, exstipulate leaves, and usually tetramerous flowers with two stamens attached to the corolla tube; the ovary is superior, and two-celled. Besides *Olea*, *Fraxinus* (ash) is an important timber tree, with reduced flowers that normally lack a perianth. There are some 21 genera, with 400 species, widely distributed but centred on Asia.

Olea europaea (common olive) *See Olea*.

oleander (*Nerium oleander*) *See Nerium*.

Olearia (daisy-bushes; family Compositae, tribe Astereae) Genus of shrubs or small trees, with alternate leaves, which differ from many members of the Compositae in having a series of involucre bracts, a naked receptacle, and anthers which are blunt-ended instead of having tails. The genus occurs only in Australasia, where it replaces the genus *Aster*, and is mainly restricted to temperate zones, often occurring as an understorey in forest, or as scrubland species. There are 80 species found in Australia, and 20 in New Zealand, and 20 in New Guinea.

olfactory centre One of the regions of the brain that are concerned with the sense of smell.

oligioclase The most common feldspar, specific gravity 2.6, hardness 6.0–6.5, chemical composition $Na(AlSi_3O_8)Ca(Al_2Si_2O_8)$. Present in most igneous rocks, oligioclase is an acid feldspar found in acid igneous rocks, e.g. granites and quartz porphyries. It is usually white or greyish-white, with a bluish or greenish tinge, and has a vitreous lustre. The mineral crystallizes in the triclinic system. The crystals are tabular or tabular-prismatic, and often occur as aggregates.

oligo- Prefix meaning few or small; in ecology it is often used to denote a lack, e.g. 'oligotrophic', nutrient-poor; 'oligomictic', subject to little mixing.

Oligocene An epoch of the Tertiary Period. It follows the Eocene and precedes the Miocene Epoch. The Oligocene Epoch began 36.5 million years ago, and lasted approximately 12.5 million years.

Oligochaeta (phylum Annelida) Class of annelid worms which possess very well-developed metameric segmentation. The segments have bristles, but parapodia are not present. They are all hermaphrodites; asexual reproduction is predominant in aquatic forms. Eyes and tentacles are absent. A few marine forms occur but most are freshwater or terrestrial. There are 15 families, and the class is first recorded from the Upper Ordovician.

oligohaline *See* brackish.

oligolectic Applied to bee species that specialize in collecting pollen from one genus or species (or from only a few genera or species) of flowering plants.

oligomictic Applied to lakes that are thermally almost stable, mixing only rarely. This condition is characteristic of tropical lakes with very high (20–30 °C) surface temperatures.

oligopeptide Linear peptide of 2–10 amino acids. *Compare* polypeptide.

Oligopygoida (class Echinoidea) Order of irregular echinoids with a small periproct. The genital plates are fused into one, with four genital pores. The ambulacra are petaloid. Lantern supports on the inside of the test are developed from both ambulacral and interambulacral plates. Oligopygoida are known only from Middle and Upper Eocene strata.

oligosaccharide Linear or branched carbohydrate of 2–10 monosaccharides.

Oligotrichida (subclass Spirotrichia) Order of ciliate protozoa in which body cilia are sparse or absent. Oral cilia are conspicuous. They are found mostly in marine environments.

oligotrophic Applied to waters poor in nutrient and with low primary productivity. Typically, oligotrophic lakes are deep, with the hypolimnion much more extensive than the epilimnion. Plankton density is low and littoral plants are scarce. The low organic content means that dissolved-oxygen levels are high, favouring fish species such as trout. By comparison with eutrophic lakes, oligotrophic lakes are considered geologically young, or little modified by weathering and erosion products.

oligotrophication The process of nutrient depletion, or reduction in rates of nutrient cycling, in aquatic ecosystems. It arises as a consequence of acidification, typically the result of pollution and most notably associated with air pollution and acid rain.

olive *See Olea*.

olive knot Type of gall that develops on olive trees infected with the bacterium *Pseudomonas savastanoi*.

olivine Rock-forming mineral, specific gravity 3.2–4.4 (increasing with iron content), hardness 6.5–7.0, chemical composition $(Mg,Fe)_2SiO_4$. It occurs in silica-poor, igneous rocks, e.g. basalt, gabbro, troctolite, and peridotite. It occurs extensively with pyroxene in dunites, and also in stony meteorites and lunar basalts. It is distinguished by its colour and fractures, and alters readily to serpentine during weathering or hydrothermal alteration. It is usually olive-green, but can sometimes be yellowish, brownish, or black; it has a vitreous lustre. It crystallizes in the orthorhombic system. Good crystals are rare, and it develops as granular aggregates.

olm *See Proteus anguinus*.

Olpidiaceae (order Chytridiales) Family of fungi which live parasitically on many types of plant. The family includes the genus *Olpidium*, species of which are common parasites in many cultivated plants.

olynthus Short-lived stage in the development of some calcareous Porifera, formed when the colony becomes attached to a substrate. It consists of a hollow, vase-shaped body composed of an inner layer of choanocytes and an outer dermal layer. Water enters through pores in the body and leaves through the 'mouth' (the osculum) of the 'vase'.

omasum (psalterium) In Ruminantia, the third chamber of the stomach, in which water is absorbed.

ombrogenous peat (ombrogenous bog) Peat-forming vegetation community lying above groundwater level: it is separated from the ground flora and the mineral soil, and is thus dependent on rain water for mineral nutrients. The resulting lack of dissolved bases gives strongly acidic conditions and only specialized vegetation, predominantly *Sphagnum* species (bog mosses), will grow. Two types of ombrogenous bogs are commonly distinguished: raised bogs and blanket bogs. *Compare* valley bog.

omentum *See* mesentery.

ommatidium One of the individual, light-sensitive units that together form a compound eye. Each ommatidium consists of a cuticular lens below which is the crystalline cone. Below this are six or seven elongated retinula cells, which have close-packed microvilli towards the centre forming a structure called the rhabdome. Pigment cells surround the retinula cells. *See also* eye.

omnivore (diversivore) Heterotrophic organism (e.g. a human) that feeds on both plants and animals, and thus operates at a range of trophic levels.

Omphalina (family Tricholomataceae) Genus of fungi in which the fruit bodies are small; the cap is convex (often with a central depression), the gills are decurrent, and the stipe is thin and central. The spores are smooth and colourless, and do not stain dark violet when treated with iodine. They are found chiefly on peaty ground in heathland.

Onagraceae Family of shrubs and herbs with tetramerous (or rarely dimerous) flowers, with twice as many stamens as petals, and an inferior ovary of four fused carpels and four cells. Many members are now grown for ornament, e.g. *Oenothera* and *Fuschia*. There are some 19 genera, comprising 470 species, with a cosmopolitan distribution.

onchocerciasis Infestation of the skin of humans by nematode worms of the species *Onchocera volvulus*, which occurs most commonly in W. Africa. It causes skin tumours, and sometimes blindness. The worms are transmitted by flies of the genus *Simulium*. *See* river blindness.

Oncoceratida (class Cephalopoda, subclass Nautiloidea) Order of very variable cephalopods, most of which have either a cyrtoconic or breviconic phragmacone that is compressed in cross-section. The siphuncle is ventral and there is little siphuncular or cameral deposit. These relatively thick-shelled cephalopods first appear in the Middle Ordovician and die out in the early Upper Carboniferous.

oncogenic Capable of causing the formation of tumours.

oncolith Spherical or sub-spherical particle, up to 5 cm across, produced by the accretion of sedimentary material on to a mobile grain through the action of algae.

oncornavirus (oncovirus) An old term for one of the tumour-inducing, RNA-containing viruses now classified in the subfamily Oncovirinae, family Retroviridae.

oncovirus *See* oncornavirus.

Ondatra zibethicus (musk rat, musquash) *See* Cricetidae.

one-gene–one-polypeptide hypothesis The hypothesis that a large class of structural genes exists in which each gene encodes a single polypeptide, which may function either independently or as a subunit of a more complex protein. Originally it was thought that each gene encoded the whole of a single enzyme, but it has since been found that some enzymes and other proteins derive from more than one polypeptide and hence from more than one gene.

Oneirodidae (class Osteichthyes, subclass Actinopterygii, order Lophiiformes) Family of marine fish related to the anglerfish. Typically, the head, mouth, and eyes are large, and the fins (apart from the tail-fin) are much reduced in size. There are about 33 species, distributed worldwide.

one-spot dottyback (*Pseudogramma polycanthus*) *See* Pseudogrammidae.

onion (*Allium*) *See* Liliaceae.

Oniscus asellus (subclass Malacostraca, order Isopoda) Common European species of terrestrial isopod, which feeds on fungi, algae, mosses, and any decomposing plant or animal matter. Bacteria present in the gut are responsible for cellulose digestion. Mainly nocturnal, they are photonegative and strongly thigmotactic, and respond to changes in humidity. They possess repugnatorial glands as a defence against spiders and ants. As in most terrestrial isopods, the brood chamber of the female is filled with fluid, freeing the species from an aquatic mode of life. *O. asellus* often occurs in gardens, hothouses, and human habitations.

ontogeny The development of an individual from fertilization of the egg to adulthood.

onychomycosis Fungal infection of the nails; causal agents may be dermatophyte fungi or species of *Candida*.

O'nyong nyong fever Disease of humans in which there is fever and there are pains in the joints. It is caused by an alphavirus, and transmitted by mosquitoes (*Anopheles*).

oocyst In some parasitic Protozoa, a zygote formed by the fusion of gametes, in which form the organism may be transmitted to a new host.

oocyte The cell that, following meiosis, forms the ovum. Most of the cytoplasmic growth involved in ovum formation is accomplished by the primary oocyte: this undergoes the first meiotic division, giving rise to two cells, the polar body, with very little cytoplasm, and the secondary oocyte, which has a large amount of cytoplasm. This latter oocyte undergoes the second meiotic division to give rise to another polar body and an ovum. Fertilization often takes place at one of the two oocyte stages.

oogenesis The formation of eggs or ova, including the meiotic division of the oocytes, and the formation of the yolk and the egg membranes.

oogonium Cell that undergoes repeated mitosis to give rise to oocytes. It forms either the female sex organ of certain algae and fungi, containing one or more oospheres, or the cell of the animal ovary.

ooid *See* oolith.

oolite Commonly occurring limestone, consisting largely of ooliths.

oolith (ooid) Sub-spherical, sand-sized, carbonate particle that has concentric rings of calcium carbonate surrounding a nucleus of another particle.

Oomycetes (subdivision Mastigomycotina) Class of fungi in which the zoospores have two flagella, one of the whiplash type and one of the tinsel type. The cell walls of oomycetes are atypical of fungi in that they contain cellulose but not chitin. The majority of species are aquatic, but some are important pathogens of terrestrial plants. The class contains four orders.

oosphere (mycol.) Female gamete contained within an oogonium. Fertilization of an oosphere is followed by the development of an oospore.

oospore (mycol.) Thick-walled resting spore formed following the fertilization of an oosphere within an oogonium.

ootheca Type of egg case produced by certain insects, best seen among the Blattodea and Mantodea. The ootheca encloses a cluster of eggs,

and is secreted by accessory reproductive glands. On exposure to air during ovipositing, the frothy secretions tan and harden.

ootype In some Platyhelminthes, the central structure of the female reproductive system, which receives eggs, sperm, and yolk cells from the ovovitelline duct. Shell forms around each egg in the ootype and the eggs leave through the uterus, to be expelled to the exterior.

oozoid In Thaliacea and some Cnidaria, an individual formed from an egg that buds asexually to produce sexually reproducing forms.

opacus From the Latin *opacus* meaning 'shady', a variety of extensive cloud that obscures the Sun or Moon. It is used to describe stratus, stratocumulus, altostratus, and altocumulus. *See also* cloud classification.

opah (*Lampris guttatus*) *See* Lampridae.

opal Mineral, specific gravity 1.8–2.3, hardness 5.5–6.5, and with the chemical composition $SiO_2.nH_2O$, whose name comes from Sanskrit and means 'gem' or 'precious stone'. It is normally deposited at low temperatures from silica-bearing waters. It occurs as fissure fillings in rocks of any kind, and especially near geysers and hot springs. It is distinguished by its form and low density. It can be colourless, or the colour can vary through milky-white to grey, red, brown, blue, green, to nearly black; and it has a resinous lustre and conchoidal fracture. It is amorphous. Its form is normally massive, but it can be stalactitic, botryoidal, and also in veinlets. The various varieties depend on the amount of water contained in the mineral, which can vary from 6% to 10%. The variety known as precious opal has a milky-white or sometimes black body colour which exhibits a brilliant play of colours, usually blues, reds, and yellows. The colours can often disappear with the loss of water when the mineral is exposed to air.

Opalinata (subphylum Sarcomastigophora) Superclass of ciliated protozoa which have nuclei of one type only. Cysts are formed. Opalinata are found as parasites in the intestines of amphibians.

open canopy Forests or woodlands where the individual tree crowns do not overlap to form a continuous canopy layer but are more widely spaced, leaving open sunlit areas within the woodland.

open population Population that is freely exposed to gene flow, as opposed to a closed one in which there is a barrier to gene flow.

open-space area Any land area to which the public has unrestricted access (although access may extend only to permission to move freely over the area on foot).

operant conditioning (instrumental conditioning) Conditioning in which an animal forms an association between a particular behaviour and a result that reinforces the behaviour, its behaviour being operant, or instrumental, in producing the result. For example, a bird that turns over dead leaves may find food beneath them, so it may come to associate turning over dead leaves with finding food. The process may be negative, as when an animal learns to associate a particular activity with an unpleasant result.

operator Region of DNA at one end of an operon that acts as the binding site for a specific repressor protein, and so controls the functioning of adjacent cistrons.

opercular flap In Holocephali, a skin flap attached to the hyoid arch: it covers the gills.

operculum A little lid. In plants, the term usually refers to the dehiscent cap present on certain moss capsules or other types of sporangia. In animals, a lid or cover. *See also* gill cover.

operon Set of adjacent structural genes whose messenger-RNA is synthesized in one piece, together with the adjacent regulatory genes that affect the transcription of the structural genes. The operon is under the control of an operator gene, lying at one end of it. Operons are concerned in the control of gene transcription leading to the formation of particular enzymes used in metabolic pathways. To date they have been found only in prokaryotes (e.g. *Escherichia coli*), but a number of homologous systems exist in lower eukaryotes such as fungi.

Ophichthidae (snake eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Large family of eel-like, marine fish, in most of which the dorsal fin extends almost the full length of the body, originating behind the head and extending either to a spike-like tail or to a tiny tail-fin. The tail is thought to be used for quick burrowing activity into the sea-bottom. Many species, e.g. *Ophichthus gomesi* (shrimp eel) of the W. Atlantic, reach a length of 60 cm; others may grow to 1.7 m. There are about 270 species, distributed worldwide.

Ophichthus gomesi (shrimp eel) *See* Ophichthidae.

Ophiclinidae (snake blenny; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine coastal fish with an elongate, almost snake-like body. Both dorsal and anal fins are long-based, but the dorsal consists of at least 40 spines with only one soft ray. They resemble blennies in that the pelvic fins are reduced to a pair of free rays in a jugular position. *Ophiclinus gracilis* (black-backed snake blenny), which grows to 6.5 cm, and another four species are found in the temperate waters of Australia and New Zealand.

Ophiclinus gracilis (black-backed snake blenny) *See* Ophiclinidae.

Ophiderpeton Specialized, snake-like amphibian from the Upper Carboniferous (Pennsylvanian) of Europe and N. America.

Ophidia (snakes) *See* Serpentes.

Ophidiidae (cusk-eel, brotula; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Fairly large family of marine fish with long, compressed bodies with minute scales. The dorsal, caudal, and anal fins are often united to form a continuous fin, although a few species possess a small, separate,

tail-fin. The pelvic fins are reduced to slender, filamentous rays in the throat region, and probably are used as feelers. The Ophidiidae inhabit the seas at all depths, with those living at greater depths possessing almost rudimentary eyes. The family includes several species of commercial importance, e.g. *Genypterus capensis* (kingklip) of S. Africa (1.5 m), which lives at depths of 100–600 m. There are about 190 species, distributed worldwide.

Ophiocistioidea (phylum Echinodermata, subphylum Echinozoa) Class of extinct, free-living echinozoans, which possess a low, dome-shaped test lacking arms. The peristome is centrally placed on the ventral surface and is enclosed in a complex jaw system. The ambulacra are confined to the ventral surface and are composed of three rows of plates. The interambulacra are narrow and consist of one plate column only. The class is known from the Ordovician to Devonian.

Ophiodon elongatus (lingcod) *See* Hexagrammidae.

Ophioglossaceae Family of primitive, eusporangiate ferns, in which the frond is forked into a sterile vegetative part and a fertile part which bears the massive, more or less sessile sporangia. There are three genera. *Botrychium* and *Ophioglossum* are cosmopolitan in distribution; *Helminthostachys* is confined to the Indo-Malaysian region.

Ophioglossum (family Ophioglossaceae) Genus of ferns with the sterile blade(s) usually simple (rarely lobed) with reticulate veins, and the sporangia sunken along the opposite sides of a simple spike, opening by transverse slits. There are 50 species, found in most parts of the world.

ophiolite (ophiolite complex) Sequence of rock types, consisting of deep-sea sediments lying above pillow lavas, dykes, gabbroic intrusions, and ultramafic peridotite. Their origin is currently in dispute, but probably they are either relics of a back-arc basin or of an ocean-ridge system.

Ophiomyxina (brittle-stars; subclass Ophiuroidea, order Phrynophiurida) Suborder of modern brittle-stars which are completely enclosed in a thick, soft skin. They are known only from the Recent.

Ophiophagus hannah (king cobra; order Squamata, suborder Serpentes (Ophidia), family Viperidae) The longest of all poisonous snakes, which may exceed 5 m in length. The neck ribs may be spread to form a small hood. It occurs in India, Malaya, and S. China.

ophiopluteus In some Ophiuroidea, applied to a larva with four pairs of elongated arms supported by calcareous rods and bearing bands of cilia.

Ophiostomataceae (order Sphaeriales) Family of fungi in which the asci are spherical and evanescent, the ascus wall disintegrating within the ascocarp. Ascospores are mostly colourless. There are four genera, with many species. They are saprotrophic or parasitic in plants.

Ophisaurus apodus (European glass lizard, glass snake; order Squamata, suborder Sauria (Lacertilia), family Anguidae) Legless lizard, very serpentine in form, which has a furrow along the lower part of each flank. It grows to a maximum length of 1.2 m. The female lays 6–10 eggs. It occurs in the Balkans, the Crimean peninsula, and SW Asia.

Ophiurida (brittle-stars; class Stelleroidea, subclass Ophiuroidea) Order of brittle-stars in which the ambulacral groove is covered by the lateral arm plates. The dorsal and ventral arm plates are well developed. Large radial shields, buccal shields, and genital plates are present in the disc. The order is known from the Silurian to Recent.

Ophiuroidea (brittle-stars; subphylum Asterozoa, class Stelleroidea) Subclass of brittle-stars in which a central, rounded disc is sharply demarcated from the long, slender arms. The body cavity of the arms is filled almost completely with axial skeleton. The subclass is known from the Ordovician to Recent.

Opiliaceae Family of trees and shrubs, very similar to Olacaceae and often included in that family, most members of which are root parasites. They have alternate, simple, entire leaves, without stipules. The flowers are regular, usually bisexual but sometimes dioecious, and held in simple or compound spikes or racemes. If present, the calyx is of four sepals and the corolla of four or five free petals. The fruit is a drupe, and the seed contains an oily endosperm. There are eight genera and 60 species, found throughout the tropics, but centred in Asia.

Opisthobranchia (phylum Mollusca, class Gastropoda) Subclass of marine organisms, which are often 'naked', including the sea slugs and pteropods, ranging from the Cretaceous to the present day. They have only one gill and are thought to represent an evolutionary grade between the prosobranch gastropods and the pulmonate gastropods.

opisthocoelous Applied to vertebrae with a concavity on the posterior surface. *See* Pipidae.

Opisthocomidae (hoatzin; order Galliformes) Monotypic family, comprising *Opisthocomus hoatzin*, which is a dark brown, rufous, and buff bird with a stout, short bill, a small head with long crest feathers, a long neck, and a long tail. It is a weak flier, normally clambering through trees. Its young possess claws on their wings and climb well. *O. hoatzin* is arboreal, inhabiting forests; feeds on fruit and leaves; and nests in trees. It is confined to northern S. America.

Opisthocomus hoatzin (hoatzin) *See* Opisthocomidae.

opisthodetic Applied to the ligament of a pelecypod when it is in a position posterior to the beaks.

Opisthognathidae (jawfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish with a long, low, dorsal fin, and a large, blenny-like mouth which enables the fish to swallow large prey. They tend to live in burrows in tropical to subtropical waters of the Atlantic and Indian Oceans. One of the larger species, *Opisthognathus aurifrons*, which grows to 12 cm, is found in the tropical W. Atlantic region. There are about 30 species.

Opisthopora (phylum Annelida, class Oligochaeta) Order of mainly terrestrial annelid worms all of which have paired testes. There are eight families, and many members are earthworms, e.g. the genera *Lumbricus*, *Glossoscolex*, and *Megascolex*.

Opisthoproctidae (barreleye, spookfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of somewhat bizarre fish: they are of variable form, but the eyes are usually tubular and directed upward. They tend to be deep-sea fish, rarely exceeding 15 cm in length. Spookfish, e.g. *Dolichopteryx longipes*, have a cosmopolitan distribution. There are about 11 species.

opisthosoma *See* Arachnida.

Oplegnathidae (knifejaw; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of robust, deep-bodied, marine fish, typically with the teeth in both jaws fused to form a parrot-like beak with sharp cutting edges. The spines of the dorsal, anal, and pelvic fins are very strong. Sometimes found during trawling in temperate Australian waters, *Ostorhinchus conwaii* (knifejaw) reaches a length of 40 cm. There are about four species, found in the Indo-Pacific region.

Oporornis (warblers) *See Geothlypis*.

opossum 1 *See* Didelphidae. 2 (possum) *See* Phalangeridae.

opossum rat *See* Caenolestoidea.

opportunist pathogen Normally non-aggressive organism, commonly a normal member of the body microflora, which under certain conditions takes on the role of a pathogen. Predisposing factors include surgery, antibiotic therapy, suppression of the normal immune responses, etc.

opportunist species *See* fugitive species.

opposable Applied to a pollex which can be turned so that its pad makes contact with the pad of each of the other digits on the same limb.

Opsanus tau *See* Batrachoididae.

optical activity Term that refers to the ability of certain compounds to rotate the plane of polarized light when in solution; rotation of light to the right is designated dextrotatory, D, or (+), and to the left laevorotatory, L, or (−). Carbohydrates and amino acids are common organic compounds that exhibit this activity. This phenomenon arises in compounds that possess asymmetric carbon atoms and therefore exist as optical isomers which are mirror images of one another. The symbols 'D' and 'L' are used to distinguish two such isomers.

optimum yield (maximum sustained yield, MSY) The theoretical point at which the size of a population is such as to produce a maximum rate of increase, equal to half the carrying capacity. The concept is of practical use in farming and has been applied widely to commercial fisheries. It forms the basis for models that predict the stocking density required to maintain optimum fish production, and the harvesting methods and food supply needed to maintain production at that level.

orange 1 (*Citrus sinensis* (sweet) and *C. aurantium* (sour)) *See Citrus*. 2 (mock orange) *See Philadelphus*.

orange-peel fungus Common name for the large fruiting bodies of the ascomycete *Aleuria aurantia*.

orange-tip butterflies *See Anthocharis cardamines*; and Pieridae.

orang-utan (*Pongo pygmaeus*) *See* Pongidae.

orbicular Disc-shaped, circular, or globular.

Orbignya (family Palmae) Genus of palms, most of which are tall, spineless, and pinnate-leaved. The inflorescences are unisexual. The fruit has a woody endocarp with basal germ pores. *O. speciosa* (babaçu) and *O. cohune* (cohune) produce oil from both mesocarp and endosperm. There are 24 species, found in tropical S. America. *Compare Elaeis*.

orbit The bony socket of the eye.

orbivirus Member of a group (genus) of viruses within the reovirus group. The virions contain several pieces of double-stranded RNA. Orbiviruses multiply in insects, some also in vertebrates. They can cause disease.

orb-web spiders *See* Araneidae.

Orchidaceae (orchids) Family of monocotyledonous plants. One of the most advanced and specialized families, with partial or total dependence on a symbiosis with a fungus (a mycorrhizal relationship). Orchids are perennial herbs with rhizomes, vertical stocks, or root tubers, sometimes totally saprophytic; many tropical species are epiphytes with pendent roots which absorb moisture from the air. The leaves are simple, entire, and parallel-veined. The flowers are borne in racemes, spikes, or panicles, or are solitary. They are irregular, with three petaloid sepals, and three petals of which one is usually enlarged into a labellum of complex and often very different form from the other two. Usually there is only one anther (two in *Cypripedium* and related genera) borne with the stigma on a column in the centre of the flower; the ovary is inferior, one-celled with numerous minute seeds in the ripe capsule. The most complex adaptations of structure, seen in the flowers of various genera and species, are concerned with intimate dependence on various insect pollinator species. Orchids form one of the largest angiosperm families, with about 800 genera, with 20 000–30 000 species, centred in the tropics. Many tropical species and hybrids are cultivated for their remarkable flowers; even in temperate areas, the smaller, terrestrial species native there are universal favourites.

Orchidantha (formerly *Lowia*; family Lowiaceae) Genus comprising two species of plants, which occur from S. China to Borneo.

orchid bees *See* Apidae.

orchids *See* Orchidaceae.

orchil Purple dye obtained from lichens of the genus *Roccella*. *See also* orseille.

Orcinus (killer whale) *See* Delphinidae.

ordination method Method for arranging individuals (or sometimes attributes) in order along one or more lines. The method is used, with many techniques, in the biological and earth sciences, and especially in biology. There is an extensive ecological literature that discusses ordination methods, their applicability to different situations, and the relative merits of ordination as opposed to classification schemes.

Ordovician The second of six periods that constitute the Palaeozoic Era, named after an ancient Celtic tribe, the Ordovices. It lasted from 500 to 430 million years ago. The Ordovician follows the Cambrian and precedes the Silurian. It is noted for the presence of various, rapidly evolving, graptolite genera and of the earliest jawless fish.

Orectolobidae (carpet shark, nurse shark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Small family of slow-moving, bottom-living sharks in which the two dorsal fins are located far back on the body. Typically, the nostrils are connected with the mouth by a pair of oro-nostral grooves. The lips and sides of the head usually bear fringes or fleshy barbels. An anal fin, always smaller than the dorsal fins, is present. Perhaps the most colourful of the carpet sharks is *Orectolobus ornatus* (gulf wobbegong), which grows to 3 m, of S. Australia. Like its relatives, e.g. *Ginglymostoma cirratum* (Atlantic nurse shark), which grows to 4.3 m, it may be dangerous only when provoked. There are about 25 species, distributed worldwide.

Orectolobus ornatus (gulf wobbegong) *See* Orectolobidae.

Oregon grape *See Mahonia*.

ore mineral Mineral, metalliferous or non-metalliferous, that may be extracted profitably from an ore-body. In mineralogy the term is applied to those minerals that may polish with a metallic lustre even when dispersed.

oreodont Member of an extinct N. American group of artiodactyls, which may have been related to the enteledonts, pigs, and peccaries. However, their molars were selenodont, suggesting that in fact they were ruminating swine. *See also* Agriochoeridae; and Merycoidodontidae.

Oreosomatidae (class Osteichthyes, subclass Actinopterygii, order Zeiformes) Small family of marine fish which have certain features in common with the Zeidae (John Dories), e.g. the large, distensible mouth; a deep, compressed body; large eyes; and a small tail-fin. *Neocyttus rhomboidalis* (spiky dory), which is typical of the family, lives at depths of more than 600 m near the coasts of S. Africa and S. Australia. There are about seven species, distributed worldwide.

orf virus Virus which causes the disease 'orf' in lambs and kids, and can also (rarely) infect humans. The disease involves the formation of vesicles on mouth and nose, the vesicles becoming ulcerated or warty. The virus is related to the poxviruses.

organelle Within a cell, a persistent structure that has a specialized function.

organic evolution The evolution of life.

organic matter In particular, the organic material present in soils; more generally, the organic component of any ecosystem.

organic soil Soil with a high content of organic matter and water. The term usually refers to peat. The USDA defines an organic soil as one with a minimum of 20–30% organic matter, depending on the clay content.

organismic Applied to groups of organisms, or communities, that are thought to have properties (e.g. homoeostasis or reproduction) similar to those of a single living organism, making them 'supra-organisms'. The term is most used to describe plant communities by those who consider that discrete climax vegetation entities, e.g. beech–oak woodlands, may be identified. These units will necessarily show a high degree of internal interdependence of species, and on the maturity and death of a community another identical plant association will replace it. This organismic concept forms the theoretical basis for a classificatory approach to the description of vegetation communities and their analysis. *Compare* individualistic hypothesis.

organotroph Organism that obtains energy from the metabolism of organic compounds. Sometimes inaccurately used as a synonym of heterotroph. *Compare* lithotroph.

Oriental faunal region Area that encompasses India and Asia south of the Himalayan–Tibetan mountain barrier, and the Indonesian archipelago, excluding New Guinea and the Celebes. There are marked similarities with the Ethiopian region (e.g. both have elephants and rhinoceroses) but there are endemic groups, e.g. pandas and gibbons.

oriental sore *See* Delhi boil.

orientating response Spontaneous reaction of an animal to a stimulus, in which the head and/or body are moved so that the source of the stimulus may be examined more thoroughly.

original-natural *See* natural.

orioles 1 *See* Icteridae; *Icterus*. 2 *See* Oriolidae; and *Oriolus*.

Oriolidae (Old World orioles; order Passeriformes) Family of mainly yellow and black, red and black, or green birds which have stout, red, blue, or black bills. Orioles of the genus *Sphecotheres* have bare, red skin around the eye. They are arboreal, feed on insects and fruit, and nest in trees. There are two genera, 28 species, many of them migratory, found in Europe, Africa, Asia, and Australasia.

Oriolus (Old World orioles; family Oriolidae) Genus of orioles, many of which, e.g. *O. oriolus* (golden oriole), have yellow and black males, and green females. Other species are red and black, black, or green. Their bills are red or blue, and most have distinctive, fluty songs. They are strictly arboreal, most inhabiting evergreen forest. There are 24 species, some migratory, found in Europe, Africa, Asia, and Australasia.

Oriolus oriolus (golden oriole) *See Oriolus*.

Ormosia (family Leguminosae, subfamily Papilionatae) Genus of trees in which the leaves are pinnate. The flowers have five subequal petals. The pods contain a few large, shiny, scarlet seeds. The timber is hard and heavy. There are 90 species, with a pantropical distribution.

ornate threadfin bream (*Nemipterus hexodon*) *See* Nemipteridae.

ornithine Non-protein amino acid which, in the liver of vertebrates, contributes to the conversion of ammonia and carbon dioxide into urea.

Ornithischia One of two orders of Mesozoic dinosaurs, distinguished primarily on the basis of a bird-like pelvis. Ornithischian dinosaurs were exclusively vegetarian and produced both bipedal forms (the ornithopods) and four-footed forms.

ornithocoprophilous Preferring habitats rich in bird manure.

ornithomimid One of the coelurosaurs, which were theropod dinosaurs from the Upper Cretaceous. They are referred to as the 'ostrich dinosaurs' because of their general build, and their name means 'bird imitators'.

Ornithopoda Suborder of ornithischian dinosaurs which had an essentially bipedal gait, including several families, e.g. iguanodonts and hadrosaurs. The ornithopods are regarded as the most primitive of the ornithischian suborders.

Ornithorhynchidae (platypus; subclass Prototheria, order Monotremata) Family of nocturnal monotremes which are highly adapted for aquatic life. The digits are webbed, the webs of the forelimbs being folded when the animal is not swimming, and those of the hind limbs bear strong claws. The snout is covered in thick skin and is shaped like the bill of a duck. A spur on the inside of the hind leg carries venom. The animal feeds on aquatic invertebrates. Breeding takes place in spring, with 1–3 eggs being laid and incubated in a nest built in a burrow beside water. The animals are distributed throughout S. and E. Australia and Tasmania. There is one species, *Ornithorhynchus anatinus*.

ornithosis Disease of birds caused by the bacterium *Chlamydia psittaci*. Humans can also be infected. Sometimes the term 'ornithosis' is used synonymously with 'psittacosis', and sometimes it is reserved for the infection in birds only, 'psittacosis' being reserved for the disease in humans.

Orobanchaceae Family of totally parasitic herbs, devoid of chlorophyll, and often specific root parasites of particular angiosperms. The flowers are borne in spikes or racemes, or rarely are solitary, on stems that bear only scale-like leaves. The flowers are irregular and two-lipped, and very close in structure to those of the Scrophulariaceae, but the ovary is one-celled, though with a two-lobed stigma, and there are four stamens. The fruit is a capsule. There are some 11 genera, with 130 species, occurring chiefly in the warmer temperate parts of the Old World.

orogeny Mountain building, especially when a belt of rock is compressed by lateral forces to form a chain of mountains. There have been many orogenic episodes in the evolution of the crust.

orographic Applied to the rain or cloud caused by the effects of mountains on airstreams that cross them. Orographic cloud and rain are produced by the forced uplift of moist air and the consequent condensation when this is cooled to saturation point.

oroya fever Acute, infectious disease endemic in parts of S. America. Symptoms include anaemia and fever. The causal agent, *Bartonella bacilliformis*, is transmitted by sandflies (*Phlebotomus*).

orseille Purple dye, obtained from lichens of the genus *Roccella*. *See also* orchil.

Ortalis (chachalacas; family Cracidae) Genus of small, rather plain, brown cracids which have a bare, red throat patch. Many have chestnut in their wings and tail. They inhabit brush; feed on fruit, shoots, and leaves; and nest in trees. There are nine species, found in C. and S. America.

Orthida (class Articulata) Extinct order of brachiopods, which have biconvex shells, a straight hinge line, and well-developed cardinal areas on both valves. The pedicle opening notches into both valves and is not usually restricted by plates. The shells are usually impunctate. Orthida ranged from the Lower Cambrian to the Upper Permian. The order comprises three suborders, with five superfamilies, 32 families, and many genera.

orthite (allanite) Mineral, specific gravity 3.4–4.2, hardness 5.0–6.5, and with the chemical composition $(Ca,Ce,Y,La,Th)_2(AlFe)_3Si_3O_{12}(OH)$, which often occurs as an accessory mineral in granitic rocks, syenites, gneisses, and skarns. It is distinguished by its dark colour, pitchy lustre, and radioactivity. It is light brown to black, and has a pitchy to sub-metallic lustre. It crystallizes in the monoclinic system. The crystals are normally prismatic, often tabular, and sometimes massive.

orthoclase Rock-forming mineral, specific gravity 2.5, hardness 6.0–6.5, chemical composition $K(AlSi_3O_8)$, which is found in acid and intermediate acid, igneous rocks, e.g. granite pegmatites. It is a member of the feldspar group of minerals. It can be light pink, brownish-yellow, reddish-white, or beef-red, and has a vitreous lustre. It has two perfect cleavages at right angles. It crystallizes in the monoclinic system. The crystals are normally well-formed prisms, and twinned crystals are common. It is used for the manufacture of glass and ceramics.

orthoconic Applied to the conch of a cephalopod when it is a straight, tapering cone.

orthogenesis Evolutionary trends that remain fairly constant over long periods of time and so appear to lead directly from ancestor organisms to their descendants. This was once explained as the result of some internal directing force or 'need' within the organisms themselves. Such metaphysical interpretations have been displaced by the concepts of orthoselection and species selection.

orthokinesis Movement of an animal in response to a stimulus, such that the speed of movement is proportional to the strength of the stimulus.

Orthomyxoviridae (orthomyxoviruses) A group (family) of viruses which contain an RNA genome consisting of several pieces of linear RNA. The virions are enveloped. The group includes the influenza viruses.

Orthonectida (phylum Mesozoa) Order of small, elongate mesozoans, whose life cycle is simpler than that of the Dicyemida. They are endoparasitic within some marine invertebrates.

Orthopsida (class Echinoidea) Order of regular echinoids with simple ambulacral plates, perforate, non-crenulate tubercles, and keeled teeth. They are known only from Jurassic and Cretaceous rocks.

Orthoptera (crickets, grasshoppers, locusts; class Insecta) Order of medium to large, terrestrial insects, whose major diagnostic features include hind legs that are usually modified for jumping (saltatorial), and a pronotum with large, external flanges. Orthopterans are exopterygote, and the external wing buds reverse their orientation in later instars. The forewings are modified as tegmina. Wings are reduced or absent in some members of all the larger families. Stridulation is commonly exhibited, with the mechanisms involved and the nature of the sounds produced varying widely. Many species live in association with plants, while others are found on the ground among debris, or under rocks. A number of groups burrow in the ground, and some are cave-dwelling. One family even lives in ant nests. Orthopterans may be nocturnal or diurnal, cryptically or brightly coloured, solitary or gregarious. Most species are herbivorous, but some are omnivorous, and a few are predacious. Kentromorphism is exhibited by certain groups, most notably the locusts. Of the more then 20 000 species, some are of economic significance.

orthoselection Primary selective pressure of a directional kind, which results in a self-perpetuating evolutionary trend. Species selection has been advanced as an alternative explanation for such trends. *See also* Dollo's law.

Orthotrichiales (subclass Bryidae) Order of medium-sized acrocarpous mosses in which the leaves are ovate to lanceolate, with or without a nerve. The capsules are held erect and are usually ovoid with a double peristome; each capsule may be covered with a bell-shaped, often hairy, calyptra. They are found typically on trees; some species are found on rocks and walls. Genera include *Orthotrichum* and *Ulota*.

ortstein Indurated horizon in the B horizon of podzols (Spodosols), in which the cementing materials are mainly iron oxide and organic matter.

Orussidae (parasitic woodwasps; suborder Symphyta, superfamily Siricoidea) Small and relatively rare family of symphytans which differ from other groups in having a long, slender, curved ovipositor which is spirally twisted within the body of the female. The adults resemble horntails but are much smaller and behave like chalcids. The antennae arise below the eyes and just above the mouth, and the eyes are hairy (a feature unique among the Symphyta). Little is known about the biology of the adults, but they may feed on frass and fungi in the tunnels of wood-boring beetles. The apodous (without legs) larvae are ectoparasitic on the larvae of cerambycid and buprestid, wood-boring beetles. The family is regarded as representing an intermediate stage between the Symphyta and the Apocrita.

Orycteropodidae (aardvark; superorder Protoungulata, order Tubulidentata) Family of animals, known from the Miocene in Africa and the Oligocene in Europe, that are isolated from all other mammal groups and that may be similar to condylarths. An orycteropoid is about the size of a small pig. The teeth are peg-like; they consist only of premolars and molars in the form of columns of dentine with no enamel, and grow continuously. The snout is long, the mouth round, the tongue long and worm-like. The animal is able to bury its snout in earth and locate and swallow prey while continuing to breathe. The limbs are specialized for digging, and digging is used as a means of escape from danger as well as to obtain food. The olfactory region of the brain is highly developed. The ears are long and the sense of hearing acute. There is only one extant species, *Orycteropus afer* (aardvark) distributed throughout Africa south of the Sahara.

Oryzias latipes (medaka) *See* Oryziatidae.

Oryziatidae (medaka; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of egg-laying toothcarps. Mainly surface-living fish, they are small and inhabit freshwater floodplains as well as coastal brackish-water marshes. They are closely related to the true toothcarps (Cyprinodontidae). The slim-bodied *Oryzias latipes* (medaka), which grows to 4 cm, shows a flattened head with a single dorsal fin placed near the tail. A good aquarium fish, its biology is well known due to extensive research carried out by Japanese workers. There are about seven species, found in the river systems of E. Asia.

oscillation ripple Small ridge of sand formed by wave action on a sea- or lake-floor. Such ripples commonly display rounded symmetrical troughs and sharp symmetrical peaks, although many wave-generated ripples are not symmetrical owing to an inequality in forward and backward motion associated with the wave action. *See also* ripple.

Oscillatoria (order Nostocales) Genus of filamentous cyanobacteria, in which the filaments are composed of disc-shaped cells and may reach lengths of more than 1 cm. They are capable of gliding motility. Sheaths are often not apparent, and heterocysts and akinetes are not formed. Oscillatoria are common in all types of aquatic environment, often forming dark green mats on wet rocks, etc.

oscillatory wave Wave that causes a mass of water to move to and fro about a point but not to undergo any appreciable net displacement in the direction of wave advance. The wave-form advances but the

individual water particles move in closed or nearly closed orbits.

Oscinella frit (frit fly) *See* Chloropidae.

os innominatum In adult Reptilia, Aves, and Mammalia, in which the pubis, ilium, and ischium bones of the pelvis are fused into a single bone, one of the two lateral halves of the resulting bone.

Osmeridae (smelt; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of fish including both freshwater and marine representatives. Like the salmon, the smelts have a single, soft-rayed, dorsal fin as well as an adipose fin on the back, a forked tail, and the pelvic fins located in a mid-ventral position. Most species are fairly small and inhabit the cooler waters of the northern hemisphere. Many marine species are anadromous, migrating into the rivers to spawn. *Osmerus eperlanus* (European smelt), which grows to 20 cm, *Mallotus villosus* (Atlantic capelin), which grows to 25 cm and lives in the Atlantic, as well as other smelts are of considerable commercial value, as food, fishmeal, or bait. There are at least 10 species.

Osmerus eperlanus (European smelt) *See* Osmeridae.

Osmia *See* mason bee.

osmophilic Applied to organisms that grow best in habitats containing relatively high concentrations of salts or sugars, i.e. those having a relatively high osmotic pressure.

osmoregulation Process whereby an organism maintains control over its internal osmotic pressure irrespective of variations in the environment.

osmosis The movement of water or of another solvent from a region of low solute concentration to one of higher concentration through a semi-permeable membrane.

osmotic potential The part of the water potential of a tissue that results from the presence of solute particles. It is equivalent to osmotic pressure in concept but opposite in sign.

osmotic pressure The pressure needed to prevent the passage of water or other pure solvent through a semi-permeable membrane separating the solvent from the solution. Osmotic pressure rises with an increase in concentration of the solution. Where two solutions of different substances or concentrations are separated by a semi-permeable membrane, the solvent will move to equalize osmotic pressure within the system.

osmotrophic Applied to an organism that absorbs nutrients from solution, as opposed to ingesting particulate matter.

Osmunda (family Osmundaceae) Genus of large ferns with massive, erect rhizomes, and bipinnate leaves. The sporangia are borne mostly on the upper margins of specialized pinnules without lamina or chlorophyll, and are massive, short-stalked structures. There are some 12 species, cosmopolitan in distribution but absent from Australasia.

Osmundaceae Family of eusporangiate ferns of primitive type and ancient ancestry. The sporangia, all developing together, are massive and short-stalked and have a group of thick-walled cells at their apices, instead of a ring (annulus) of thickened cells as in more modern ferns. There are five genera, with about 30 species, found throughout most of the world.

osphradium Water-sampling organ, common to all neogastropods and also found for example in the chitons of other gastropods, that can detect very small amounts of chemicals in solution. Scenting for prey is its primary use. It consists of a patch of sensory epithelium on the posterior margin of afferent gill membranes which acts as a chemoreceptor and determines the amount of sediment in the water being inhaled.

Osphronemidae (giant gourami; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family comprising *Osphronemus goramy* (the giant gourami), which inhabits swamps and rivers, but is also cultured in ponds as a food fish in S. Asia. Somewhat oval in outline, the giant gourami will grow into a rather heavy, robust fish reaching a length of about 65 cm. It is easily recognizable by the very long pelvic fin-rays, and a rather large anal fin. It is closely related to other gouramis and labyrinth fish of the family Belontiidae.

osprey *See* Falconiformes; and Pandionidae.

ossicles 1 In Echinodermata, irregularly fenestrated calcareous plates, rods, and crosses arranged to form a lattice and bound together by connective tissue; together they comprise the skeleton. 2 Small bones.

Ostariophysi Long-established name for a group of fish possessing the Weberian ossicles (modified vertebrae) and including the carps and catfish. The name has been reintroduced recently for a superorder of bony fish including the orders Cypriniformes, Gonorynchiformes, and Siluriformes.

Osteichthyes Class of bony fish; with more than 25 000 species it is the largest class of vertebrate animals. Typically, bony fish have a bony skeleton, gill chambers covered by a gill cover or operculum, and usually a swim-bladder; there are usually many flat, bony scales embedded in the skin, with epidermis over them. *See also* Teleostomi.

Osteoglossidae (bony tongue, spotted barramundi; class Osteichthyes, subclass Actinopterygii, order Osteoglossiformes) Small family of freshwater fish with an elongate, robust body. The single dorsal fin is located close to the small, rounded, tail-fin; the ventral fins are placed in a mid-ventral (abdominal) position. It is considered a fairly primitive family. Representatives are found in S. America, W. Africa, N. Australia, and SE Asia. *Scleropages leichardti* (the spotted barramundi or saratoga) of N. Australia is a prized sport fish, reaching a weight of up to 5 kg. Females are known to carry eggs and larvae in the mouth for some time (buccal breeding). The S. American *Arapaima gigas* grows to a length of 4.5 m and is one of the world's largest freshwater fish. There are about six species.

Osteoglossiformes Order of freshwater fish including several families with fossil relatives. All have a single, soft-rayed, dorsal fin; low-placed pectoral fins; small, mid-ventral, pelvic fins; and a long-based anal fin. The order includes the Notopteridae (featherback), Hiodontidae (moon-eye), Osteoglossidae (bony tongue), and Pantodontidae (butterfly fish).

Osteoglossomorpha Superorder of bony fish including the orders Osteoglossiformes and Mormyriformes.

Osteostraci Order of fossil, fish-like, jawless vertebrates with a flattened head covered by a bony shield with series of small gill openings on the side. Usually small (30 cm), they ranged from the Silurian to the Devonian Periods. The internal structures of the head resemble those of extant Petromyzonidae (lampreys).

ostiole (mycol.) Opening in a fruiting body (e.g. a perithecium) through which spores are discharged to the exterior.

ostium An opening. In Porifera, one of the openings through which water is drawn into the body. In Arthropoda, one of the openings in the wall of the heart into the pericardial (blood-filled) sinus.

Ostorhinchus conwaii (knifejaw) *See* Oplegnathidae.

Ostracion lentiginosum (boxfish) *See* Ostraciontidae.

Ostraciontidae (boxfish, cowfish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Family of marine fish with the body enclosed in a hard, bony shell or carapace. Special openings are provided to accommodate the various fins. Rather slow-moving fish, they are well represented in tropical and subtropical waters, with many species entering estuaries. *Ostracion lentiginosum* (boxfish), which grows to 23 cm, and many other species are thought to discharge a toxic substance capable of killing other fish kept in the same aquarium. There are about 24 species, distributed worldwide.

Ostracoda (mussel shrimps, seed shrimps; phylum Arthropoda, subphylum Crustacea) Class of widely distributed marine and freshwater crustaceans in which the entire body is enclosed in a rounded or elliptical, bivalved carapace, the outer layer of which is impregnated with calcium carbonate. A cluster of transverse adductor muscle fibres closes the valves, the muscles being inserted near the centre of each valve. The trunk is greatly reduced, so that the head accounts for much of the body. Trunk appendages are usually reduced to two pairs and there is no external segmentation of the trunk. By contrast, the head appendages, especially the antennules and antennae, are well developed and are the means of locomotion, even in the remarkable terrestrial species of *Mesocypris*, which plough through damp humus in S. African and New Zealand forests. Ostracods show a wide range of feeding types, and the group includes filter feeders, carnivores, herbivores, and scavengers. The sexes are separate, and parthenogenesis is common in freshwater forms. There are more than 2000 living species of ostracods, and the group is known from more than 10 000 fossil species. They range from the early Cambrian to the present and are important microfossils.

Ostracodermi (ostracoderms) The name often used in older textbooks for the fossil, armoured, jawless, agnathan fish of the Ordovician to early Carboniferous. Probably the name indicates only a grade of development; some ostracoderms are close to the line of ancestry of the living Agnatha (lamprey and hagfish), others to the origin of the jawed vertebrates. The informal version of the name survives. *See also* Cephalaspidomorphi; and Pteraspidomorphi.

ostracoderms *See* Ostracodermi.

Ostreina (oysters; class Pelecypoda, order Pterioda) Suborder of epifaunal, cemented or free-living pelecypods in which the adults are non-byssate, and the foot is absent. The shell is composed of foliated calcite with an aragonitic area below the adductor muscle. In most cases oysters live cemented to a hard substrate by the left valve, in a pleurothetic attitude. They have a monomyarian musculature, the ligament is alivincular and divided into three parts, the central section being the resilium. The hinge margin is edentulous. The gills are eulamellibranch, and the pallial line lacks a sinus. Oysters first appeared in the Late Triassic.

ostrich *Struthio camelus*. *See Struthio*.

Ostropales (class Discomycetes) Order of fungi in which the asci are very long and cylindrical, and contain eight smooth, colourless, thread-like, multiseptate spores. There is one family, with several genera. The ascocarps develop on wood or on leaves.

Otariidae (sea lions; order Carnivora, suborder Pinnipedia) Family of marine mammals in which small external ears are present, there is a short tail, and the hind limbs can be turned forward to aid movement on land. They are less fully adapted to aquatic life and are considered to be evolutionarily more primitive than the Phocidae, to which they are not related closely, having arisen independently from canid stock. They may have appeared first on the shores of the Pacific during the Lower Miocene. Today they are distributed on Pacific and S. Atlantic coasts and on many islands in the southern hemisphere. There are six genera and about 14 species.

otic Relating to the region of the ear.

otic capsule The part of the skull that encloses the inner ear.

Otidae (bustards; order Gruiformes) Family of medium to large birds which have grey or brown upper-parts, buff or white under-parts, with many having black and white head and neck markings. They have broad wings, long necks and legs, and three-toed feet. They inhabit open plains, where they are mainly terrestrial, flying occasionally. They are omnivorous, and nest on the ground. There are 10 genera, with 25 species, many

endangered, found in Europe, Africa, Asia, and Australia.

Otidia (order Pezizales) Genus of fungi in which the fruit bodies are typically brown or yellowish, and are cup-shaped or ear-shaped; the hymenium lines the inner surface, and at maturity the tips of the paraphyses are bent or hooked. *Otidia* are found on the ground in a range of habitats.

otolith *See* earstone.

otters *See* Mustelidae.

otter shrew (*Potamogola*) *See* Tenrecidae.

Otus (scops owls, screech owls; family Strigidae) Genus of small, brown and grey, 'eared' owls, many of which have unfeathered legs. They are nocturnal; inhabit forest, open woodland, scrub, and desert; feed on insects, small mammals, and birds; and nest in tree holes. There are about 35 species found in Europe, Africa, Asia, and N., C., and S. America.

oubain Cardiac glycoside that inhibits the transport of sodium and potassium ions across cell membranes.

Oudemansiella (family Tricholomataceae) Genus of fungi, which form mushroom-shaped fruit bodies; the cap is white, smoky, or brownish, with broad, well-spaced gills, and a central, often long-rooting stipe. They are found on wood. *O. mucida* ('porcelain fungus') is common on beech trunks and is white, semi-translucent, and slimy. *O. radicata* ('rooting shank') has a yellow-brown to olive-brown cap with white gills, and a long-rooting stem. It is very common on roots or buried wood.

outbreeding The crossing of plants or animals that are not closely related genetically, in contrast to inbreeding, in which the individuals are closely related. *See also* cross-breeding.

outer veil *See* universal veil.

outlier 1 Area where younger rocks are surrounded completely by older rocks. It may be produced by erosion, faulting, or folding, or any combination of these. *Compare* inlier. 2 An organism that occurs naturally some distance away from the principal area in which its species is found.

outwash Meltwater escaping from the terminal zone of a glacier. The resulting streams are typically braided, and show marked seasonal variations in discharge.

outwash plain (sandur, pl. sandar) Extensive accumulation of rock debris built up by outwash in front of a glacier. Its constituents are very coarse close to the ice, and diminish in size further away. Its surface may be dissected by braided channels. Fossil outwash plains are found at the margins of many Pleistocene glaciers. The name 'sandur' is Icelandic.

outwelling The enrichment of coastal seas by nutrient-rich estuarine waters.

ovary Of a plant, the gynoecium.

ovenbirds *See* Furnariidae.

overcrowding effect Regulation of population growth by behavioural abnormalities that are caused by malfunction of the endocrine glands, which themselves occur in response to overcrowding.

overdispersion (contagious distribution) In plant ecology, a situation in which the pattern formed by the distribution of individuals of a given plant species within a community is not random but shows clumping, so that large numbers of both empty and heavily populated quadrats are recorded. *See also* pattern analysis.

overdominance (superdominance) In genetics, the phenomenon in which the character of the heterozygotes is expressed more markedly in the phenotype than in that of either homozygote. Usually the heterozygote is fitter than the two homozygotes: this can give rise to monohybrid heterosis, the hybrid vigour obtained by crossing parents differing in a single specified pair of allelic genes. *See also* balanced polymorphism.

overfishing Reduction of a population of fish to a dangerously low level due to heavy fishing either by amateur or professional fishermen, or both.

overflow channel (spillway) Valley cut by meltwater escaping from a proglacial lake. Generally it is trough-shaped in form, lacks tributaries, and is not integrated with the local drainage pattern. It is often difficult to distinguish from other varieties of meltwater channel.

overgrazing Pressure by grazing animals, either domestic or wild, which results in the degradation of pasture, leading to exposure of the bare soil surface and ultimately erosion and even desertification of the area.

over-representation In pollen analysis, the presence in considerable abundance of immediately local pollen which tends to obscure the general pattern of changes in the regional pollen-rain record, e.g. the predominance of pollen from bog plants at a peat bog site.

overspecialization An old theory which held that straight-line evolution or orthogenetic trends might proceed to the point at which the lineage was at an adaptive disadvantage. Overspecialization was therefore considered as one of the causes of extinction. There is no reason to believe, however, that natural selection would permit evolution to proceed beyond maximum adaptation. More recently the term has been applied to highly specialized organisms which have proved incapable of responding to environmental change and so have become extinct.

Ovibos moschatus (musk-ox) *See* Bovidae.

ovicell *See* Cyclostomata.

oviduct Tube carrying eggs from the ovary to the uterus; or from the coelom, into which ova are shed, to the exterior.

oviger In Pycnogonida, one of a pair of legs, located behind the palps and in front of the walking legs, used for grooming and, in the male, for carrying eggs. In females of some species the ovigers are reduced or absent.

ovine foot rot Contagious disease of the foot in sheep and goats in which portions of the hoof separate from the soft tissues; the disease is encouraged by wet conditions. The primary causal agent is the bacterium *Fusiformis nodosus*.

oviparous Applied to species that lay eggs: embryos develop outside the mother's body, each egg eventually hatching into a young animal. Little or no development occurs within the mother's body, unlike the viviparous condition. Examples of ovipary are found in birds and some reptiles, including all chelonians and crocodilians, and some (mainly tropical) snakes and lizards.

ovipositor Specialized egg-laying organ which in most insects is formed from outgrowths of the eighth and ninth abdominal segments. There are six outgrowths in all, known as valves, and these may be modified to form a variety of structures. In some insects the valves are short and in others they are drawn out to form a long, stylet-like tube. Extreme forms of ovipositor occur in the sawflies, ichneumons, and wood wasps, where it may be longer than the entire body, and equipped apically with saw teeth to aid penetration of hard plant tissues. Worker bees and sterile female wasps have the ovipositor modified to form a stinging organ and poison sac.

Ovis (sheep) *See* Bovidae.

ovoviviparous Applied to species that bear young developed from eggs retained within the mother's body but separated from it by the egg membranes. The eggs contain considerable yolk which provides nourishment for the developing embryo. Examples include many insects, snails, fish, snakes, and lizards.

ovulation The release of a ripe egg on bursting from the ovarian follicle of a mammal, frequently stimulated by a pituitary hormone. The egg is discharged on to the surface of the ovary and then passes into the oviduct. *See also* Graafian follicle.

ovule Structure in angiosperms and gymnosperms that, after fertilization, develops into a seed. In gymnosperms the ovules are unprotected, whereas in angiosperms they are protected by the megasporophyll (which forms the carpel). One or several ovules may be contained in the carpel and each is attached to the carpel wall by a stalk (funicle). When mature, the angiosperm ovule consists of a central mass of tissue, the nucellus, surrounded by one or two protective layers, the integuments, which eventually give rise to the seed coat. Within the nucellus is a large oval cell, the embryo sac, which has developed from the megaspore and contains the naked egg cell.

ovum (pl. ova) Unfertilized egg cell. In many animals it corresponds to the oocyte, since it is one of these that is fertilized by the sperm to develop as the embryo.

Owenia (family Meliaceae) Genus of trees belonging to the family of the true mahoganies, and including some important species of timber trees. The leaves are alternate, usually pinnate, and without stipules. The regular flowers are held in cymes and have 3–5 petals and the same number of sepals. The fruit is usually a capsule or drupe. Some species have edible fruits. Several species appear to reproduce only vegetatively (e.g. *O. acidula*) and their seeds may be infertile. There are six species, endemic to tropical E. Australia, where they occur most typically in the understorey of rain forests.

owlet-nightjars *See Aegotheles*; and Caprimulgiformes.

owlets **1** *See* Noctuidae. **2** *See Glaucidium*.

owlflies *See* Neuroptera.

owls **1** *See Asio*; Strigidae; Strigiformes; and *Strix*. **2** (barn owls) *See Tyto*; and Tytonidae. **3** (bay owls) *See* Tytonidae. **4** (eagle owl) *See Bubo*. **5** (pygmy owls) *See Glaucidium*. **6** (scops owls, screech owls) *See Otus*.

ox *See* Bovidae.

Oxaea *See* Oxaeidae.

Oxaeidae (order Hymenoptera, suborder Apocrita) Small, neotropical family of fast-flying, ground-nesting bees, a few of which are found also in the southern USA. Oxaeids were once considered a subfamily of the Andrenidae, which they resemble in having subantennal plates and pollen scopa that extend from the coxa to the basitarsis of the hind leg. They differ from andrenids in that the forewing lacks a stigma, and has an elongate marginal cell. The hind femora of the females are enlarged and form a plate. The family includes the genera *Mesoxaea*, *Notoxaea*, *Oxaea*, and *Protoxaea*.

Oxalidaceae Family of herbs (rarely shrubs or trees), with alternate, pinnate, palmate, or trifoliate leaves, with entire leaflets, and pentamerous regular flowers with 10 stamens, and a 3–5-celled superior ovary which lacks a beak (unlike those of the related Geraniaceae). The fruit is a capsule or rarely a berry. Modern classifications recognize eight genera, with nearly 900 species, which occur in nearly all tropical and temperate areas.

Oxalis (family Oxalidaceae) Genus of annual and perennial herbs with alternate, palmate leaves without stipules. There are one to many leaflets. The flowers are regular, bisexual, and usually solitary, with five free and persistent sepals, and five petals, often fused at the base. There are 10 stamens. The superior ovary is composed of five fused carpels, each with a separate style. The fruit is a capsule. *Oxalis* species are known for their characteristically clover-like leaves (e.g. *O. acetosella*, wood sorrel), and in many species the leaflets fold down at night. Several species are cultivated; some can be eaten; but others are troublesome weeds, e.g. *O. cernua* (Bermuda buttercup), a weed of the bulb fields of the Scilly Isles, Great Britain. There are more than 800 species, found throughout the temperate and tropical regions of the world, but centred on S. Africa, and C. and S. America.

Oxalis acetosella (wood sorrel) *See Oxalis*.

Oxalis cernua (Bermuda buttercup) *See Oxalis*.

oxaloacetic acid A dicarboxylic acid; a key intermediate in the citric-acid cycle, where it

condenses with acetyl coenzyme A to form citric acid and coenzyme A, thus initiating the cycle.

ox bow *See* cut-off.

oxic horizon Mineral subsoil horizon that is at least 30 cm thick and is identified by the almost complete absence of weatherable primary minerals, and by the presence of kaolinite clay, insoluble minerals such as quartz, hydrated oxides of iron and aluminium, small amounts of exchangeable bases, and low cation-exchange capacity. It is the distinguishing subsoil horizon (B horizon) of an Oxisol. (USDA term.)

oxidase Enzyme that catalyses reactions involving the oxidation of a substrate using molecular oxygen as an electron acceptor.

oxidation Specifically, a reaction in which oxygen combines with, or hydrogen is removed from, a substance. More generally, any reaction in which an atom loses electrons.

oxidative phosphorylation The action of a system, coupled to the electron-transport chain of mitochondria, that is responsible for the production of ATP from ADP and inorganic phosphate.

oxidative potential The potential to cause a redox reaction to occur through loss of electrons.

oxidoreductase Enzyme that catalyses oxidation–reduction reactions. Included within this group are the dehydrogenases and oxidases.

Oxisol Mineral soil, Oxisols comprising a soil order of USDA Soil Taxonomy, distinguished by the presence of an oxic horizon within 2 m of the soil surface, or with plinthite close to the soil surface, and without a spodic or argillic horizon above the oxic horizon.

Oxyaena Lower Eocene wolverine-like carnivore, which was one of the most powerful predators of its time. *Oxyaena* was rather like a wolverine and probably was the ancestor of *Patriofelis*, which was the size of a bear, and of *Sarkastodon*, which was much larger even than that. It is known from N. America and E. Africa. *See also* Oxyaenidae.

Oxyaenidae (superorder Ferae, order Creodonta) Extinct family of carnivores which appeared during the late Palaeocene and flourished during the Eocene, but were extinct by its end. The large, deep jaw was mounted on a broad skull and in most forms carnassials were developed from the first and second molars. Most oxyaenids were rather like mustelids in shape, although *Paleonictis* resembled a cat. *See also Oxyaena*.

oxygen demand The amount of oxidizable material present in an effluent, stream, etc.

oxygen-isotope analysis Method for estimating past ocean temperatures. The ratio of the stable oxygen isotopes, ^{18}O : ^{16}O, in water is temperature-dependent, ^{18}O increasing as temperature falls. Oxygen incorporated in the calcium-carbonate shells of marine organisms will reflect the prevailing ^{18}O : ^{16}O ratio. Acidification (to release oxygen) of these fossils under carefully controlled conditions can therefore be used, with appropriate calibration, to indicate the past temperature record.

oxygen method Estimation of gross primary productivity by monitoring rates of production of oxygen, the by-product of photosynthesis. In field practice this principle is most often used for productivity measurement in aquatic ecosystems. Paired 'light and dark' bottles are filled with water from the required sample depth and suspended at this level for several hours. The dark bottle records oxygen uptake by respiration of phytoplankton and other micro-organisms during the measurement period. Changes in oxygen levels in the light bottle reflect production in photosynthesis as well as loss in respiration. Assuming that respiration rates in the paired bottles are similar, gross primary productivity may be estimated by adding oxygen loss in the dark bottle to the change recorded in the light bottle. The light bottle alone records net community productivity. Net primary productivity estimates are only possible in dense phytoplanktonic communities, e.g. algal blooms in which the oxygen loss due to respiration of other micro-organisms is proportionately very small.

oxygen quotient (QO_2) Volume, in microlitres, of oxygen taken up at normal temperature and pressure in one hour by one milligram of plant tissue.

oxygen sag Characteristic fall and recovery in the curve of dissolved-oxygen percentage-saturation levels in streams, rivers, etc. downstream from a major pollution source such as a sewage works, brewery, or pulpmill.

Oxylobium (family Leguminosae, subfamily Papilionoideae, tribe Podalyrieae) Genus of small, xerophytic shrubs, found as a component of dry scrubland or heath in Australia. The leaves are pinnate or simple, usually alternate, and stipulate. The flowers are irregular, coloured red or yellow, and held in terminal or axillary racemes. The calyx lobes overlap; often the upper two are broader. The petals are often clawed at the base, with a heel and wings all of the same length. There are 10 free stamens. The fruit is a nut containing several seeds. There are 27 species, all endemic to Australia and found throughout the continent.

Oxyruncidae (sharpbill; order Passeriformes) Monotypic family, comprising *Oxyruncus cristatus*, which is a small, olive-green bird with black, spotted under-parts, and orange-red crown stripe, and a short, sharply pointed bill. It inhabits forest in C. and S. America, and feeds on fruit.

Oxyruncus cristatus (sharpbill) *See* Oxyruncidae.

oxytocin Peptide hormone, secreted by the mammalian neurohypophysis, which causes the contraction of smooth muscle (particularly that of the uterus) and the secretion of milk.

Oxyura (stifftails; family Anatidae) Genus of small ducks which have long, stiff, tail feathers. Drakes have chestnut plumage and broad, blue bills. *Oxyura* species inhabit shallow inland waters, feed on invertebrates and vegetable matter, and nest on a reed platform in water vegetation. There are six species found in Europe, Africa, Asia, N., C., and S. America, and Australia. *O. jamaicensis* (N.

American ruddy duck) has been introduced to Britain.

Oxyura jamaicensis (N. American ruddy duck) *See Oxyura*.

Oyashio current Western boundary current in the subpolar gyre of the N. Pacific. It originates in the Bering Sea and flows south-west off the Kurile Islands to meet the Kuroshio current east of N. Japan. The current is slow moving (less than 50 cm/s), cold (4–5 °C at 200 m depth), and has a low salinity (33.7–34.0 parts per thousand).

oystercatchers *See* Haematopodidae.

oyster fungus Edible fruit body of *Pleurotus ostreatus*. The pileus is more or less shell-shaped, and variable in colour from bluish-grey to yellowish-brown. Whitish gills are strongly decurrent, anastomosing near the base. The fungus is typically found in clusters on trunks, tree-stumps, etc., and is common throughout the year.

oysters *See* Ostreina.

oyster thief Common name for the brown seaweed *Colpomenia peregrina* (family Scytosiphonaceae). The thallus is a thin-walled, hollow sphere up to 20 cm in diameter; it is yellowish-green to olive-brown, and smooth but not shiny. It grows attached to seaweeds or shells on the middle to lower shore. The common name derives from the fact that at low tides the spheres tend to fill with air and act as floats, raising any oysters that are attached to them.

ozone layer The atmospheric layer at 15–30 km altitude, in which ozone (O_3) is concentrated at 1–10 parts per million. Ozone also occurs in very low concentration at 10–15 km and 30–50 km. Generally, atmospheric ozone is produced by the photochemical dissociation of oxygen (O_2), by absorption of ultraviolet solar radiation, to form atoms of oxygen (O). These atoms collide with molecular oxygen to form ozone, which in turn absorbs solar radiation for further dissociation to O and O_2. The ozone layer limits the amount of ultraviolet radiation reaching the ground surface. *See also* atmospheric structure.

P

P *See* phosphorus.

P *See* parental generation.

P_n (NPP) Net primary productivity. *See* primary productivity.

P_{700} The pigment that acts as the energy trap of photosystem I in chloroplasts. It is thought to be chlorophyll *a* in a special structural environment. It represents about 0.3% of the total chlorophyll and absorbs light, most strongly at a wavelength of 700 nm.

pacarana (*Dinomys*) *See* Dinomyidae.

pacas *See* Dasyproctidae.

Pachycephala (whistlers; family Muscicapidae) Genus of large-headed, stout-billed birds, many of which are coloured yellow and green, or brown and rufous, some with black heads. They inhabit woodlands, thickets, and scrub, feed on insects, and nest in trees. There are 28 species, found in SE Asia, Indonesia, New Guinea, Australia, and Pacific islands.

Pachycephalosauridae 'Bone-headed' dinosaurs of the Upper Cretaceous, which were ornithopods and apparently may have lived in herds in upland regions.

pachydont Applied to a type of hinge dentition, found in certain cemented pelecypods, in which the teeth are heavy, very large, and generally few in number.

pachyostosis Condition, e.g. in Sirenia, in which bones have a solid structure, with little or no marrow.

Pachyptila (prions; family Procellariidae) Genus of small, blue-grey petrels with distinctive black wing markings, and a black-tipped tail. They are oceanic, feed on zooplankton, and nest in burrows. There are 3–6 species, found in southern oceans, breeding on sub-antarctic islands.

Pachyramphus (becards; family Tyrannidae) Genus of black, grey and white, or rufous birds which have stout bills. They inhabit forests, scrub, and open areas; feed on fruit and insects; and build a domed nest with a side entrance. There are 11 species, found in C. and S. America.

pachytene *See* meiosis; and prophase.

Pacific Coast forest The densest and most majestic coniferous forest in the world, extending from the north of California to the south of British Columbia. It is famed for its giant trees, the best known being *Sequoia sempervirens* (coastal redwood), *Sequoiadendron giganteum* (big tree), and *Pseudotsuga taxifolia* (Douglas fir). All may exceed 100 m in height and even 110 m in the case of the big tree, and the girths of certain redwoods are often greater than 20 m.

Pacific North American floral region Part of Good's (1974) Boreal kingdom, distinguished by about 300 endemic genera. Although the flora as a whole has contributed few economic plants, it has furnished numerous garden species. Like all floras of Mediterranean-type climates, the Californian part of this region shows a marked degree of endemism, with 30–50% of its species restricted to the state of California.

Pacific Ocean The largest of the world's major oceans (179.7×10^6 km^2). It is also the coldest (3.36 °C), deepest (4028 m average), and least saline (34.62 parts per thousand) of the ocean basins.

Pacific sandfish (*Trichodon trichodon*) *See* Trichodontidae.

Pacific saury (*Cololabis saira*) *See* Scomberesocidae.

Pacific softpout (*Melanostigma pammelas*) *See* Zoarcidae.

Pacific veil-fin (*Velifer multispinosus*) *See* Veliferidae.

padang Tropical heath-forest of SE Asia growing on podzolic soils severely depleted of nutrient. It is a type of keranga.

padauk *See Pterocarpus*.

paddlefish *See* Polyodontidae.

paedogenesis Reproduction by larval or other immature forms. Larval paedogenesis occurs in insects of the genus *Tanytarsus* (order Diptera, family Chironomidae), in which larvae produce eggs that can hatch into larvae which develop into males or females. Pupal paedogenesis occurs in insects of the genus *Henria* (order Diptera, family Cecidomyidae), in which pupae can produce broods of larvae. This mode of reproduction results from hormonal imbalances in the immature stages.

paedomorphosis Evolutionary change that results in the retention of juvenile characters into adult life. It may be the result of neoteny or progenesis. It permits an 'escape' from specialization, and has been invoked to account for the origin of many taxa, from subspecies to phyla.

Paenungulata (infraclass Eutheria, cohort Ferungulata) Superorder comprising herbivorous animals which diverged from the primitive Palaeocene ungulate stock to become 'subungulates' or 'near ungulates'. The superorder includes the orders Hyracoidea (hyraxes), Proboscidea (elephants, their ancestors, and other elephant-like forms), Pantodonta, Dinocerata, Pyrotheria, Embrithopoda, and Sirenia (sea-cows or mermaids). In all of them the ulna and fibula are complete, and the upper bones of the limbs are long. The digits bear nails but not hoofs. Molars are specialized for grinding, and the

incisors and canines are often reduced and modified to form tusks.

Paeonia (peony; family Ranunculaceae) Genus of tall herbs or shrubs, with large, terminal, usually solitary flowers with five sepals, 5–13 large free petals, many stamens, and 2–5 free carpels with fleshy walls, mounted on a fleshy disc. The fruit is a group of several seeded follicles. The ovules have peculiar outer integuments and the basic chromosome number is five, features not seen in other genera of the family. There are some 50 species, occurring in Eurasia and in western N. America.

Pagellus bogaraveo (red sea bream) *See* Sparidae.

pagoda tree (frangipani) *See Plumeria*.

Paguridae (hermit crabs; subclass Malacostraca, order Decapoda) Family of crustaceans which use empty gastropod shells as cover for their soft abdomens. The abdomen spirals to the right, and the shell is held by tubercles on the uropods, by abdominal contraction, and by the larger, left uropod which hooks round the columella of the shell. As the crab grows, it selects new shells with great care, the colour contrast, weight, and fit being gauged before the crab takes up occupancy. In several species the shells become overgrown by sponges or bryozoan colonies. The chelae are subequal, or sometimes with the right one larger and modified as an operculum to close the shell. Pleopods are reduced except on the left side, where they function for respiratory current production and for egg attachment. Hermit crabs are very active inhabitants of coastal and deep waters.

Pagurus bernhardei (hermit crab; order Decapoda, family Paguridae) Species of hermit crabs which grow up to 35 mm long. Large specimens carry *Buccinum* shells covered with the hydrozoan *Hydractina echinata*. They occur in N. European waters.

pahoehoe *See* lava.

painted snipe *See* Rostratulidae.

painter (*Puma concolor*) *See Puma*.

pala The hair-fringed scoop found on the tarsus of the forelegs of filter-feeding corixids. This structure is used as a diagnostic characteristic. *See also* Corixoidea.

Palaeanodonta (cohort Unguiculata, order Edentata) Extinct suborder, comprising three known genera, of primitive edentates which lived in N. America from the late Palaeocene to the Oligocene, and which may resemble the animals from which later edentates evolved although they themselves occurred too late to be considered ancestral. The incisors were absent; the cheek teeth were pegs with no enamel, reduced in number and in some forms probably replaced functionally by pads of horny material; but the canines were large. The vertebrae had not been modified in ways found in later edentates. Claws were well developed and there was a tendency for the wrist to be twisted. The most complete fossils are those of *Metacheiromys*, an animal about 45 cm long which probably fed on small invertebrates which it dug from the ground.

Palaearctic faunal region Region coincident with Europe, Asia north of the Himalayan–Tibetan physical barrier, N. Africa, and much of Arabia. Despite its size and great range of habitats, the faunal variety in it is far less than that of the Ethiopian and Oriental faunal regions to the south of it, e.g. monkeys are nearly absent and reptiles few in number. The region is similar at the family level, and rather less so at the generic level, to the Nearctic region: a Bering land bridge connected the two for much of the Cenozoic Era.

Palaechinoida (subclass Perischoechinoidea) Extinct order of Palaeozoic regular echinoids in which the plates were not strongly imbricate. About 10 genera are known.

palaeobotany The study of fossil plants.

Palaeocene The lowest epoch of the Tertiary Period. It began 65 million years ago and lasted approximately 11 million years.

Palaeodonta (superorder Paraxonia, order Artiodactyla) Extinct suborder of small mammals which lived during the Eocene and early Oligocene, mainly in N. America, and are classed as artiodactyls because of the modification of the astragalus to typical artiodactyl form. Otherwise they had departed little from the original eutherian stock. Most were short-legged, had four digits on each limb, and were neither ruminants nor entirely pig-like. The earlier forms may be the true ancestors of later artiodactyls, but the later forms left no descendants.

palaeoecology The application of ecological concepts to fossil and sedimentary evidence to study the interactions of Earth surface, atmosphere, and biosphere in former (prehistoric) times.

Palaeoheterodonta (phylum Mollusca, class Pelecypoda) Subclass of equivalve pelecypods which have prismatic-nacreous, aragonitic shells, and a small number of teeth that diverge from the umbo. The external ligament is opisthodetic or amphidetic, and parivincular. The hinge plate is present in some forms, and the musculature is variable. The subclass first appeared in the Middle Cambrian, and contains one extinct and two extant orders.

palaeolimnology The study of the history and development of freshwater ecosystems, especially lakes.

Palaeoloricata (class Amphineura, subclass Polyplacophora) Order of primitive, thick-shelled polyplacophorans, some of which are very elongate. Plate sculpture may be present as transverse ridges. They range in age from Upper Cambrian to Upper Cretaceous.

palaeomagnetism Field of geophysics concerned with the measurement and interpretation of remanent magnetism or the record of the Earth's past magnetic field. Much valuable information has been obtained concerning polar wandering and continental drift.

Palaeomerycidae (infraorder Pecora, superfamily Cervoidea) Family of pecorans that appear to be ancestral to the deer and giraffes, and of which the

musk deer (*Moschus*) may be a surviving representative. The limbs and teeth resembled those of later groups. Most forms lacked horns, and some had enlarged upper canines which formed tusks. Where horns existed they appear not to have been shed and probably they were covered with skin, as in modern giraffes or in the short pedicel at the base of deer antlers. The family had a wide Holarctic distribution during the late Oligocene and Miocene, and some genera survived into the Pliocene.

Palaeonemertini (phylum Nemertini, subclass Anopla) Order of elongate, nemertinid worms in which the muscles of the body are layered. The epidermis is ciliated, and the dermal layer is not well developed.

palaeontology The study of fossil flora and fauna. Information thus gained may be used to establish ancient environments.

Palaeopterygii Older name for a supposed subclass including some of the more primitive fish. They were bony fish with many fossil relatives, including for example the families Acipenseridae, Polyodontidae, and Polypteridae.

Palaeorhiza *See* Colletidae.

palaeosol (paleosol) Soil formed during an earlier period of pedogenesis, and which may have been buried, buried and exhumed, or continuously present on the landscape until the current period of pedogenesis.

palaeospecies (chronospecies) Group of biological organisms, known only from fossils, which differs in some respect from all other groups.

Palaeotaxodonta (phylum Mollusca, class Pelecypoda) Subclass of Pelecypoda which contains only one order, Nuculoida.

Palaeotaxus rediviva First recorded species of the Taxales (yew) family. Found in the Lower Jurassic of Europe, it is distinguished by the form of the leaf and the structure of the cuticle. The Taxales, unlike the conifers, have a single ovule surrounded by a berry-like structure. They bear terminal seeds.

Palaeotheriidae (order Perissodactyla, suborder Hippomorpha) Extinct family of horse-like animals which lived in Europe during the Eocene and Oligocene. They appear to have diverged from the main line of equid evolution and in some respects anticipated developments that were to occur later among the true horses. Several grew to large size, one (*Palaeotherium magnum*) to about the size of a rhinoceros, but they had only three toes on each foot, and had molarized premolars. One form had slim lateral metapodials and cement on the crowns of its molars. The family had disappeared by the Oligocene.

Palaeotropical floral kingdom (realm) Region whose geographical extent varies with the authority consulted. Good's (1974) definition embraces the African (excluding the Cape), Indo-Malaysian, and Polynesian subkingdoms. Other authorities adopt a more restricted definition, embracing most of Africa, Arabia, and the north-west part of the Indian subcontinent.

Palaeozoic The first of the three eras of the Phanerozoic. It began 570 million years ago and lasted 345 million years. The Cambrian, Ordovician, and Silurian Periods together form the Lower Palaeozoic sub-era; the Devonian, Carboniferous, and Permian the Upper Palaeozoic sub-era. During the Palaeozoic two major orogenies occurred, the Caledonian during the Lower Palaeozoic and the Variscan in late Palaeozoic times. The faunas of the Palaeozoic are noted for the presence of many invertebrate organisms including trilobites, graptolites, brachiopods, cephalopods, and corals. By the end of the era, amphibians and reptiles were major components of various communities and giant tree-ferns, horsetails, and cycads gave rise to extensive forests.

Palaquium (family Sapotaceae) Genus of medium to large rainforest trees which yield moderately to very hard, sometimes siliceous, timber (bitis, and nyatoh). There are 115 species, occurring from Malesia to the Pacific islands, but concentrated in Borneo and the Philippines.

palatal teeth Teeth that are borne on one or more of the bones of the palate.

palate The roof of the mouth; it separates the nasal and mouth cavities. In Mammalia and Crocodilia bones project inward from the jaws to form a false palate below the original palate, so extending the nasal cavity and moving its opening to a position in the throat. In mammals the bony part of the (false) hard palate is extended at the rear of the mouth by membrane and connective tissue which form the soft palate.

pale Deer-proof fence erected around the perimeter of a park.

palea *See* Gramineae.

Palinuridae (spiny lobsters; subclass Malacostraca, order Decapoda) Family of large, edible decapods which have a more or less cylindrical cephalothorax and a well-developed, dorsoventrally flattened abdomen. The head bears large, spiny antennae, and in most species the first pair of legs is not enlarged. The family occurs in tropical waters.

Pallas's sandgrouse (*Syrrhaptes paradoxus*) *See Syrrhaptes*.

pallette *See* Ricinidae.

pallial line In most pelecypods, a linear feature which runs between the two adductor muscles on the inner surface of the shell, and close to the margin. It delimits the extent of the inner calcareous shell layer, and marks the line of marginal mantle muscles.

pallium The part of the cerebrum concerned with olfaction.

Palmae (palms) Family of solitary or clumped, small or tall, unbranched trees whose leaves are palmate or pinnate, the leaflets being plicate. The flowers are small, trimerous, and unisexual or bisexual, the inflorescence having various bracts. Fruits are mostly one-seeded berries or drupes, fleshy to dry, and indehiscent, varying greatly in size from pea-like to the double coconut (*Lodoicea*).

Many species are ornamentals, and many yield valuable economic products, including thatch (e.g. *Nypa*), starch (e.g. *Metroxylon*), and oil (*Cocos* and *Elaeis*). There are about 212 genera and 2780 species, chiefly tropical, but some subtropical, and a few occurring as temperate outliers.

palmate Of leaves, compound with two or more leaflets arising from the top of a stalk or rachis. The main nerves of a leaf may be palmate, a situation in which several more or less equally large ones diverge along the blade from an origin at the top of the petiole. Such leaves commonly have a divided margin, i.e. are palmately lobed.

palmately lobed Applied to a leaf that is divided like the fingers of a hand. *See* palmate.

palmate newt *See Triturus helveticus*.

palmchat *See* Dulidae.

palmelloid Applied to an algal colony composed of an indefinite number of non-motile cells embedded in a gelatinous or mucilaginous matrix. It may occur as a non-motile phase in a normally motile species.

palmetto palm *See Sabal*.

palm-nut vulture (*Gypohierax angolensis*) *See* Accipitridae.

palm wine *See Raphia*.

Palmyra palm *See Borassus*.

Palouse prairie Distinctive tract of prairie in the Palouse region of SE Washington (USA), but similar prairie also extends into Oregon, S. Idaho, and N. Utah. A rich growth of bunch grasses, especially *Agropyron spicatum* (blue-bunch wheatgrass), occurs on the deep, highly fertile soils formed in aeolian parent materials. Much of the Palouse prairie is now cultivated for wheat.

palp In an insect, a jointed, sensory structure that articulates with the labium or maxillae. *See also* labial palp; and maxillary palp.

Palpigradi (microwhipscorpions; class Arachnida) Order of minute arachnids in which the prosoma is covered by a propeltidium and two tergites. The abdomen is joined by a stalk, and has a large mesosoma and a short metasoma, with a long, multisegmented flagellum. Microwhipscorpions are colourless and thin-skinned, and are probably closely related to the uropygids and amblypygids. The chelicerae are thin, three-segmented, and chelate, with a movable lateral finger. The 50 or so species favour habitats of high humidity (under stones and soil), and although they have a worldwide distribution most occur in S. Europe, southern USA, and S. America.

palsa Mound or ridge, largely made from peat, containing a perennial ice lens, and found in the damper sites of bogs in periglacial areas. Widths are in the range 10–30 m, lengths 15–150 m, and heights 1–7 m. Probably palsas are a result of heaving associated with the growth of segregated ice. *See also* pingo.

palsa bog Boggy tundra, in which ground ice is partly responsible for the formation of peat hummocks up to 35 m long, 15 m wide, and 7 m high. They are circumpolar in distribution and are apparently subfossil features which are now being degraded.

Paludicellea (class Gymnolaemata, order Ctenostomata) Suborder of bryozoans whose individuals possess elongated, thin, proximal ends. They are known only from the Recent.

palynology (pollen analysis) The study of pollen grains and spores, and especially their use in reconstructing the vegetational history of an area. The outer coat, or exine, of a pollen grain or spore is very characteristic for a given family, genus, or sometimes even species. It is also very resistant to decay, particularly under anaerobic conditions. Thus virtually all spores and pollen falling on a rapidly accumulating sediment, anaerobic water, or peat are preserved. Since both pollen and spores are generally widely and easily dispersed, they give a better picture of the surrounding regional vegetation at the time of deposition than do macroscopic plant remains, e.g. fruits and seeds, which tend to reflect only the vegetation of the immediate locality. With careful interpretation palynology enables examination of climatic change, human influence on vegetation, and sediment dating, as well as direct study of vegetation character. The technique has also been applied, more controversially, to the pollen and spore contents of modern and fossil soil profiles. Studies of contemporary pollen and spores are useful in medicine (e.g. in allergy studies and patterns of disease spread), in commerce (e.g. for the examination and quality control of honey), in agriculture (e.g. for plant and animal disease control), and even in forensic science.

pamirs *See* punas.

pampas Temperate S. American grassland, the largest continuous area being in the E. Argentinian province of Buenos Aires, together with parts of the adjacent provinces. Much of the moister-sector pampas is now cultivated, but formerly it was covered by bunch grasses, in between the individual tussocks of which the soil lay bare. To the west and south-west drier conditions prevail, and here the pampas comprised a mixture of short grasses and xerophytic shrubs.

Pampas floral region Part of Good's (1974) Neotropical kingdom: it lies east of the Andes, and between the tropical flora of Brazil and the temperate flora of Patagonia. The flora is relatively poor, with only about 50 endemic genera, all of them small. In terms of vegetation the region is dominated by the pampas. Few garden plants and no very important economic plants come from this region.

pampero Regional storm of the line-squall type which affects Argentina and Uruguay. Sometimes the storm brings rain, thunder, and lightning, and its passage is marked by a fall in temperature. The storm moves ahead of a south-westerly wind, which follows a depression.

PAN (peroxyacetyl nitrates) Air pollutants formed during the production of photochemical smog.

They are serious eye irritants and cause crop damage. They are thought to result from the interactions of reactive hydrocarbons and nitrogen oxides (which are by-products of the combustion of hydrocarbons, e.g. by internal-combustion engines) in the presence of strong sunlight when these substances accumulate in the atmosphere due to a temperature inversion. Other products of photochemical smog include ozone and aldehydes.

pan Soil horizon, usually in the subsoil, that is strongly compacted, indurated, cemented, or very high in clay content.

Panaeolus (family Coprinaceae) Genus of fungi in which the fruit bodies are mushroom-like. The gills are greyish, becoming black or mottled with black at maturity; they do not undergo autodigestion. The spores are large, and appear smooth and dark brown under the microscope. They are found on the ground, on dung, on rotting wood, etc.

Panama-hat palm (*Carludovicia palmata*) *See Carludovicia*.

Panax (family Araliaceae) Genus of tropical, E. Asian, and N. American plants, the roots of several species of which provide the oriental tonic ginseng.

panbiogeography Term coined by L. Croizat to describe a new synthesis of the sciences of plant and animal distribution. The main features are that consistencies recur in distribution patterns and that analysis of these produces 'tracks' (joining areas of common floras and faunas) and 'nodes' (where different tracks meet). These ideas form the basis of the new school of vicariance biogeography.

pancake tortoise *See Malacocherys tornieri*.

panda 1 (giant panda, *Ailuropoda melanoleuca*) *See* Procyonidae. 2 (red panda, *Ailurus fulgens*) *See* Procyonidae.

Pandaceae Small family of trees in which the leaves are simple. The flowers are unisexual, small, regular, and pentamerous. The fruit is usually a flattened drupe. The family is related to Euphorbiaceae. There are four genera, with 28 species, occurring in tropical America and Asia.

Pandanaceae Family of trees and climbers in which the leaves are strap-like, leathery, with a spiny margin, in three or four conspicuous spirals. The flowers are small, unisexual, and held in heads subtended by a large, often coloured bract (not *Sararanga*). The fruit is a berry or drupe, sometimes woody, united with the perianth into a globose or cylindrical head. There are three genera, with 700 species.

Pandanus (screw pines; family Pandanaceae) Genus of monocotyledonous trees, which usually have stilt roots, and open, falsely dichotomously branched crowns. The leaves are in three spiral ranks. The fruit heads are often reddish. Some fruits are edible (especially those occurring in New Guinea and Micronesia). Leaves are used for matting. There are 600 species.

pandemic Outbreak of disease that affects individuals throughout a large geographical region (e.g. a country) or in many different parts of the world at the same time.

Pandinus imperator *See* Scorpiones.

Pandion *See* Pandionidae.

Pandionidae (osprey; order Falconiformes) A monotypic family, *Pandion haliaetus* is a large, brownish-black and white bird of prey. Its bill is short and strongly hooked, its wings are long and pointed, and its feet have long toes and claws, the outer toe being reversible, and the soles having sharp scales for gripping prey. It inhabits coastal areas and inland fresh water, and feeds on fish caught with its feet. It nests in a tree or on the ground. It is found worldwide.

Pandorea (Australian bower plant; family Bignoniaceae) Genus of lianes, climbing shrubs, and woody plants, which have decussate, compound leaves without stipules. The flowers are brightly coloured, and held in cymes with a tufted, five-lobed calyx, and bell-shaped, lobed corolla. The flat, winged seeds develop in a capsule. Several species are grown as ornamentals. There are eight species, occurring in the rain forests and *Eucalyptus* forests of C. and E. Australia, and Malaysia.

Pandorina (family Volvocaceae, order Volvocales) Genus of green algae in which the cells fit closely together in spherical colonies (coenobia) of 4–32 cells. They are common in puddles, ponds, lakes, rivers, etc.

Panellus (family Tricholomataceae) Genus of fungi in which the fruit body has a lateral or rudimentary stipe, or no stipe at all. The spore print is white, and the spores stain dark violet when treated with iodine. They are found on wood.

pan-endemic distribution *See* cosmopolitan distribution.

Pangaea A single supercontinent which came into being in late Permian times and persisted for about 40 million years before it began to break up at the end of the Triassic Period. It was surrounded by the universal ocean of Panthalassa.

Pangasiidae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater catfish with a high dorsal fin, a small adipose fin, one pair of chin barbels, a long anal fin, and a forked tail-fin. Some of the smaller species, e.g. *Pangasius sutchi*, are well known to aquarium hobbyists; others, e.g. *Pangasianodon gigas*, can exceed a length of 2 m in their native SE Asian waters. There are about 25 species. The members of this family are sometimes included in the family Schilbeidae.

Pangium (family Flacourtiaceae) Genus of trees in which the leaves have palmate nervation. The flowers are unisexual. The fruits are globose, large, woody, and contain numerous large seeds, embedded in pulp. The plants are poisonous in all their parts, but the seeds are edible after leaching, and contain an edible oil. The dried fruits are used as rattles in New Guinea. There is one species, *P. edule*, which occurs in rain forests from Malesia to the Pacific islands.

pangolin *See* Manidae.

panicle Strictly, an inflorescence that is a compound raceme, i.e. one that comprises several racemose parts. More loosely, the term is applied to any complex, branched inflorescence.

panmictic unit A local population in which mating is completely random.

panmixia The process of panmixis.

panmixis The random mating of individuals, contrasting with assortative mating in which there is a tendency for some individuals to mate with others of a particular type.

pannage The common of mast: (a) the right to allow pigs to feed on common land where the land comprises oak or beech woodland; and (b) money paid for permission to allow pigs so to feed.

Pannariaceae (order Lecanorales) Family of lichens in which the thallus is squamulose to foliose; the lower surface is covered with short, dense hairs (tomentum). The phycobiont is a cyanobacterium. There are three species, found in moist regions on various types of non-calcareous substrate.

pannus From the Latin *pannus* meaning 'shred', an accessory cloud term applied to ragged cloud either beneath or attached to another cloud, usually cumulonimbus, cumulus, nimbostratus, or altostratus. *See also* cloud classification.

panplain (panplane) Area of very subdued relief that consists of coalesced floodplains. It is therefore due to lateral stream migration. A component of a peneplain, it is well developed in the Carpentaria region of Australia.

panplane *See* panplain.

pansies *See Viola*; and Violaceae.

panther 1 (*Panthera* (*Leo*) *pardus*, leopard) *See Panthera*; and Felidae. 2 (*Puma concolor*, puma) *See Puma*; and Felidae.

Panthera (*Leo*; superfamily Feloidea, family Felidae) Genus of 'large cats', e.g. lion (*P. leo*), tiger (*P. tigris*), jaguar (*P. onca*), leopard (*P. pardus*), and snow leopard (*P. uncia*). They are distinguished by the structure of the hyoid region, but some authorities consider this distinction arbitrary and prefer to include members of the genus with *Felis*.

panther cap Common name for the poisonous fruit body of *Amanita pantherina*, which is mushroom-shaped, and brown or olive-brown, with white patches adhering to the surface. It is found on the ground under broad-leaved trees.

Pantodonta (Amblypoda; cohort Ferungulata, superorder Paenungulata) Extinct order of ungulates which lived during the Palaeocene and Eocene, mainly in N. America, but surviving into the Oligocene in Asia. Early forms were small (e.g. *Pantolambda* was the size of a large dog), had short limbs, and large, broad feet. Later forms grew much larger (e.g. *Barylambda*, which was about 2.4 m long); some developed claws rather than hoofs; and in some the canines became enlarged, probably enabling them to feed on roots.

Pantodontidae (freshwater butterfly-fish; class Osteichthyes, subclass Actinopterygii, order Osteoglossiformes) Monospecific family of small freshwater fish with a straight dorsal outline, keel-shaped belly, large scales, and large, obliquely oriented mouth. The only species, *Pantodon buchholzi*, is of interest because of its large, wing-like, pectoral fins, supported by special muscles capable of moving the fins up and down. Kept in aquaria, these fish have been known to jump out of the tank if no cover was provided. In their native W. African rivers they can jump and glide above the water, presumably in pursuit of fast-moving prey.

pantothenic acid Vitamin B_3, synthesized by green plants and micro-organisms, but not by animals, for which it is an essential dietary requirement. It forms part of the structure of the key metabolic compound coenzyme A.

Pantotheria (class Mammalia, subclass Theria) Extinct infraclass of primitive Middle and Upper Jurassic mammals, known from N. America, Europe, and E. Africa. They were egg-laying insectivores of shrew-like appearance, and are believed, on the basis of the structure of the jaw and teeth, to include the ancestors of all later placental and marsupial mammalian groups. They were distributed widely by the later Jurassic, were numerous, and were varied in form.

Pan troglodytes (chimpanzee) *See* Pongidae.

pantropical distribution The distribution pattern of organisms that occur more or less throughout the tropics. The plants in this category are mainly weedy, herbaceous species, but there are a few woody types, e.g. Palmae (palms).

Panura biarmicus (bearded reedling) *See* Paradoxornithidae.

Papaveraceae (poppies) Family of herbs (or rarely, shrubs) with alternate, usually deeply lobed leaves; milky latex occurs in canals in all parts of the plants. The flowers are regular, commonly with two sepals that soon fall, and usually with four overlapping, crinkly petals. The stamens are free and numerous; the ovary is superior, of two to many fused carpels, producing a capsule that opens by valves or pores when ripe. Many species and genera are cultivated for their brilliant flowers; *Papaver somniferum* (opium poppy) is the source of opium and of heroin. There are some 25 genera, with 115 species, distributed through most of the world.

Papaver somniferum (opium poppy) *See* Papaveraceae.

papaya (*Carica papaya*). *See Carica*.

paper mulberry (*Broussonetia papyrifera*) *See Broussonetia*.

paper-reed (*Cyperus papyrus*) *See Cyperus*.

paper wasps (superfamily Vespoidea, family Vespidae) Social wasps which build their nests from chewed wood pulp. Most belong to the subfamilies Vespinae, Polistinae, and Polybiinae, and the name

is sometimes restricted to the Polistinae. The nest structure is variable, with or without outer coverings, but is usually spherical and contains a large number of cells. Nest construction is started by the queen in spring and the nest is subsequently enlarged by many generations of workers. Nests sometimes attain 35 cm or more in diameter.

Papilionatae (family Leguminosae) One of the three subfamilies of Leguminosae, of plants in which the leaves are pinnate, trifoliate, or simple. The flowers are usually zygomorphic, the sepals and petals imbricate, the lowest petal innermost in the bud, and there are usually 10 stamens. There are 400–500 genera, including many temperate, herbaceous plants.

Papilionidae (Apollo butterflies, birdwing butterflies, swallowtails, swordtails; order Lepidoptera) Family of spectacular butterflies, medium to large in size, and frequently brightly coloured. In most species the hindwings are extended into 'tails'. Unlike the Nymphalidae, all the legs are functional. Adults and larvae are usually distasteful. Protrusible, odiferous, forked sacs are present on the thorax of the larva. There are about 530 species. The family is widely distributed but mostly tropical.

Papillionaceae *See* Leguminosae.

papillomavirus Member of a group (genus) of viruses within the Papovaviridae. The viruses are species-specific and can infect a wide range of animals, including humans; they cause papillomas (i.e. small tumours or warts).

papillon d'amour *See Pthirus pubis*.

Papio (baboons) *See* Cercopithecidae.

Papovaviridae Family of viruses in which the genome is a double-stranded, closed loop of DNA. The virions show icosahedral symmetry. The viruses can infect a wide range of animals, and many are capable of inducing tumour formation (i.e. they are oncogenic).

pappus Tuft of hairs or bristles, derived from the calyx, that terminates the fruit of many Compositae and Valerianaceae.

paprika *See Capsicum*.

Papuan mountain drongo (*Chaetorhynchus papuensis*) *See* Dicruridae.

papulae *See* Asteroidea.

papyrus *See Cyperus*.

parabasal body In certain flagellate Protozoa, a small granular mass located close to the blepharoplast. It was known formerly as the kinetonucleus, but apparently serves no function associated with movement or with the nucleus.

Parablastoidea (subphylum Pelmatozoa) Class of echinoderms, restricted to the Lower and Middle Ordovician, with biserial brachioles, well-developed pentameral symmetry, and ambulacra composed of biserial plates.

parabolic dune *See* dune.

Paracanthopterygii Recently recognized superorder of bony fish, including the orders Batrachoidiformes, Gadiformes, Lophiiformes, Percopsiformes, and Polymixiiformes.

Paracheirodon innesi (neon tetra) *See* Characidae.

paracoccidioidomycosis Disease of humans caused by the fungus *Paracoccidioides brasiliensis*. Lesions develop in the skin, mucous membranes, and internal organs.

Paracomatulacea (feather-stars; subclass Articulata, order Comatulida) Superfamily of primitive feather-stars in which the centro-dorsal region consists of closely adpressed columnals, either fused or articulating. The superfamily first appears in the Lower Jurassic and has continued to the present day.

paracone In primitive triconodont upper molar teeth, either the anterior cusp (where the three cusps form a straight line), or the outside anterior cusp (where they are not in line).

Paracrinoidea (subphylum Pelmatozoa) Class of echinoderms with uniserial brachioles, and a box-like theca composed of numerous plates tending to bilateral symmetry. They are restricted to the Middle and Upper Ordovician.

paradigm Essentially, a large-scale and generalized model that provides a viewpoint from which the real world may be investigated. It differs from most other models, which are abstractions based on data derived from the real world.

Paradisaeidae (birds of paradise; order Passeriformes) Family of small- to medium-sized birds, which have brightly coloured, iridescent plumage and elaborate plumes on the head, back, wings, and tail; some also have wattles. Females tend to be dull-coloured. The bill is short to long, straight and slender, and highly decurved or hooked. The wings are short and rounded, the tail short and square to long and graduated. The birds are arboreal: they feed on insects, frogs, lizards, fruit, and seeds, and nest in a cavity or tree fork. Their plumes are used in highly elaborate displays which also involve unusual vocal sounds. There are 20 genera, comprising 43 species, found mainly in New Guinea, but also in Australia and the Moluccas.

paradise fish (*Macropodus opercularis*) *See* Belontiidae.

Paradoxornis (parrotbills; family Paradoxornithidae) Genus of typical parrotbills which have very stout, laterally compressed, yellow or orange bills. They are gregarious; inhabit forest, scrub, and reeds; feed on insects and seeds; and nest in trees or shrubs. There are about 18 species, confined to Asia.

Paradoxornithidae (parrotbills; order Passeriformes) Family of small- to medium-sized, long-tailed birds which have short, deep, parrot-like bills. Their plumage is soft and mainly reddish-brown. They inhabit forest, scrub, and reedbeds; feed on insects and seeds; and nest in trees, bushes, and reeds. *Panurus biarmicus* (bearded reedling) is the only parrotbill in Europe. There are three genera, with about 20 species, found in Europe and Asia.

Parafidelia *See* Fideliidae.

parakeela *See Calandrinia*.

Paralepididae (barracudina; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Fairly large family of marine, mid-water fish which have slender, streamlined bodies, pointed heads, and a single dorsal fin located half-way along the back. They are fairly common deep-sea fish, with few species exceeding 32 cm in length. There are about 50 species, distributed worldwide.

Paralichthys californicus (California halibut) *See* Bothidae.

parallel evolution Similar evolutionary development that occurs in lineages of common ancestry. Thus the descendants are as alike as were their ancestors. The nature of the ancestry imposes or directly influences the development of the parallelism.

Paramecium (suborder Peniculina) Genus of ciliate protozoa in which the cells are elongated or ovoid, and range in size from 0.05–0.33 mm, depending on species and conditions. Body cilia are arranged uniformly, and two contractile vacuoles are usually present. There are many species. They are common in various types of aquatic environments, and feed mainly on bacteria.

parametric test *See* statistical method.

paramo Humid alpine meadow and scrub of the Andes, situated between the tree-line and the snow-line, and deriving much moisture from cloud or mist.

paramylum In some phytoflagellate Protozoa, a granular carbohydrate food reserve.

paramyosin Form of tropomyosin found in the adductor and retractor muscles of bivalve molluscs. It is a water-insoluble protein and forms filaments 100 nm thick.

paramyxoviruses (Paramyxoviridae) Group (family) of viruses in which the virions are enveloped and contain a single molecule of RNA. Paramyxoviruses are responsible for a range of diseases in humans and other animals, including mumps, measles, and Newcastle disease.

paraña pine *See Araucaria*.

Paranthropus Genus recognized by some authorities to describe the robust australopithecines, often classified as *Australopithecus robustus* or *A. boisei*. They were early protohominids, the sister group of *Homo*. Members of the genus, often called 'nutcracker man', were characterized by enormous molars and premolars, and reduced front teeth. They were common at such sites as Olduvai and Koobi Fora, in the Late Pliocene and Early Pleistocene.

parapatric Applied to species whose habitats are separate but adjoining. *Compare* allopatric; and sympatric.

parapatric speciation Speciation that occurs regardless of minor gene flow between demes. In many species selective pressures are sufficiently strong on the whole to prevent homogenization of the immigrant genes by interbreeding.

Parapercidi Alternative name for the fish family Mugiloididae.

Parapercis colias (blue cod) *See* Mugiloididae.

paraphyletic Of a taxon, including some but not all descendants of the common ancestor, i.e. not holophyletic.

paraphyses Sterile, thread-like filaments found among the asci in the fruiting bodies of many fungi in the Ascomycotina. In mosses, club-shaped or hair-like structures found among the gametes in an antheridium or an archegonium.

Parapithecidae (order Primates, suborder Anthropoidea, superfamily Cercopithecoidea) Extinct family of primates which lived during the Eocene and Oligocene in Asia (Burma) and Africa (Egypt). They showed certain similarities in dentition to condylarths, but had short faces, and jaws resembling in shape those of tarsiers.

Paraplesiops bleekeri (Bleeker's devilfish) *See* Plesiopidae.

parapodium 1 In Polychaeta, usually biramous, muscular, lateral projections of the body, paired and extending from the body segments, more or less compressed laterally, and bearing setae; in free-swimming forms they are used for locomotion, and in sessile forms to fan water. 2 In opisthobranch Mollusca, lateral projections from the side of the foot which form fins used in swimming.

para rubber (*Hevea brasiliensis*) *See Hevea*.

Parashorea (white seraya, white lauan; family Dipterocarpaceae) Genus of 11 giant timber trees which occur from S. China to the Philippines.

parasite *See* parasitism.

Parasitica One of the two customary divisions of the suborder Apocrita (order Hymenoptera). The Aculeata are the stinging forms (ants, bees, and wasps) and the Parasitica are those whose larvae parasitize other insects. There are four principal superfamilies: Ichneumonoidea, Chalcidoidea, Cynipoidea, and Proctotrupoidea.

parasitic barnacles *See* Rhizocephala; and *Sacculina carcini*.

parasitic castration *See Sacculina carcini*.

parasitic catfish *See* Trichomycteridae.

parasitic flies *See* Tachinidae.

parasitic woodwasps *See* Orussidae.

parasitism Interaction of species populations in which one, typically small, organism (the parasite) lives in or on another (the host), from which it obtains food, shelter, or other requirements. Parasitism usually implies that some harm is done to the host, but this interpretation must be qualified. Effects on the host range from almost none to severe illness and eventual death, but even where such obvious immediate harm accrues to the individual host it does not follow that the relationship is harmful to the host species in the long term or in an evolutionary context—for example, it might favour beneficial adaptation in

the host species population. Obligate parasites can live only parasitically. Facultative parasites may live as parasites or as independent saprophytes. Ectoparasites live externally on the host. Endoparasites live inside the body of the host. A partial parasite is a plant that carries out photosynthesis, but that relies on its host for other nutrients and needs, e.g. support. *Compare* commensalism; mutualism; and neutralism.

parasitoid *See* hyperparasite.

parasitology The study of small organisms (parasites) living on or in other organisms (hosts), regardless of whether the effect on the hosts is beneficial, neutral, or harmful. The study uses the term 'parasite' in a wider sense than is usually associated with parasitism.

parasol ants *See* Attini; fungus garden; and Myrmicinae.

parasol mushroom Common name for the edible fruit body of *Lepiota procera*. *L. rhacodes* is known as 'shaggy parasol'. Both species have a scaly cap, and an annulus (ring) which is loose and can be moved up and down the stipe.

parataxon Artificial classification suggested for certain common organisms of doubtful affinities, or as yet unknown origins, e.g. conodonts, fossil spores, dinosaur footprints.

Paratetrapedia *See* Anthophoridae.

paratype Specimen, other than a holotype, used by an author at the time of the original description, and designated as such by the author.

paratyphoid fever Disease which resembles typhoid fever. Symptoms include fever and gastroenteritis. It is caused for example by *Salmonella paratyphi* or *S. typhimurium*. Infection occurs by ingestion of contaminated food or water.

Paraxonia (infraclass Eutheria, cohort Ferungulata) Superorder comprising the extinct and extant members of the order Artiodactyla.

paraxonic Applied to the condition in which the axis of the weight of an animal passes between the third and fourth digits.

parcel of air Quantity of air with more or less uniform characteristics.

parchment bark *See Pittosporum*.

pardalotes *See* Dicaeidae.

Pareiasauridae The largest (up to 3 m in length) of the stem reptiles (cotylosaurs), the pareiasaurs are found in Middle and Upper Permian rocks in Europe and Africa. They were herbivorous, and perhaps lived semi-aquatically in swamps. They were distinctive among cotylosaurs in that the limbs were rotated in towards the body, thus supporting the body in a more upright fashion.

parenchyma 1 In plants, tissue composed of thin-walled, live cells permeated by air spaces. 2 In Platyhelminthes, the tissue, composed of cells and intercellular spaces, filling the interior of the body. 3 In other animals, the essential cells of an organ, as opposed to blood cells, cells of connective tissue, etc.

parenchymula A poriferan (sponge) larva in which the area of non-flagellate cells is very small.

parental generation (P) The generation comprising the immediate parents of the F_1 generation. The symbols P_2 and P_3 may be used to designate grandparental and great-grandparental generations respectively.

parent material The original material from which the soil profile has developed through pedogenesis, usually to be found at the base of the profile as weathered but otherwise unaltered mineral or organic material.

Paridae (tits, chickadees; order Passeriformes) Family of small, active birds which are blue, olive, brown, or grey above, and white, yellow, or buff below. They have small, stout bills, and many have crests. Their wings are short and rounded, their tails short and square-ended. They are arboreal, inhabiting woodland and gardens; feeding on insects, nuts, and seeds; and nesting in holes in trees and banks, and in nestboxes. There are three genera, with 49 species, found in Europe, Africa, Asia, and N. and C. America.

parietal 1 One of a pair of bones that form much of the posterior part of the roof of the braincase. 2 Applied to the lining on the inside of the body wall. 3 (bot.) *See* placentation.

parivincular Applied to a type of pelecypod ligament that is elongate and cylindrical in shape. It occurs in a position posterior to the beaks.

park 1 In ancient farming systems, the enclosed fields lying between the inner fields next to the farm buildings, and the larger, outer fields used only seasonally for pasture. 2 Enclosed land on which deer are or were kept. 3 Land, usually wood-pasture, enclosed by a pale, and intended for the keeping of deer. 4 In modern use, an area of land set aside for public enjoyment and designed to resemble semi-natural land.

Parkia (family Leguminosae, subfamily Mimosoideae) Genus of trees which usually have bipinnate leaves. The flowers are in globular heads on long stalks held free from leaves, and are mostly nocturnal, and bat-pollinated. Pods or seeds of some are eaten as a relish (petai). There are 40 species, with a pantropical distribution.

park woodland Woodland in which there is an open canopy of mature trees over pasture.

Parmelia (family Parmeliaceae) Large genus of lichens in which the thallus is foliose and is frequently attached to its substrate by means of rhizines on the lower surface. The phycobiont is the green alga *Trebouxia*. The apothecia are lecanorine. Spores are colourless and aseptate. *Parmelia* species are found on trees, rocks, etc.; some are very common.

Parmeliaceae (order Lecanorales) Family of lichens in which the thallus is foliose, and has a cortex on both surfaces; the lower surface frequently bears rhizines. There are several genera, and many species, found on a wide range of substrates, and widely distributed.

Parnassiaceae *See* Saxifragaceae.

paroccipital process At the rear of the base of the skull, a downward-projecting spur to which is attached the muscle used in opening the lower jaw.

Parodontidae (class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish which have a single, soft-rayed, mid-dorsal fin, small adipose fin, and a ventrally positioned mouth. They are found in S. American rivers.

Paromomyidae (order Primates, suborder Plesiadapiformes) Extinct family comprising the earliest known primates, which may have originated during the late Cretaceous, when they were contemporaries of dinosaurs. They flourished in the Palaeocene, and died out in the middle Eocene. Most are known only from their teeth, but a few skulls and limb bones are now known. Probably they were the size of modern shrews, herbivorous, and lived on or close to the ground.

parr Term often used to indicate the juvenile, freshwater stage of salmon of various species. Parr bearing dark spots or bars tend to stay in the rivers for periods of at least two years before turning into smolt and migrating to the sea.

parrotbills *See Paradoxornis*; and Paradoxornithidae.

parrotfish *See* Scaridae.

Parrotia (family Hamamelidaceae) Genus of handsome, slow-growing, small, ornamental trees or shrubs which have fine autumn colouring. The flowers are held in clusters subtended by white bracts. There is one species, *P. persica*, which is confined to the warm-temperate forests of Iran.

parrots **1** *See* Psittacidae; and Psittaciformes. **2** (Amazon parrots) *See Amazona*. **3** (budgerigar) *See Melopsittacus*. **4** (conures) *See Pyrrhura*. **5** (lories) *See Lorius*. **6** (pygmy parrots) *See Micropsitta*.

parsnip *See Pastinaca*.

Parsonia (family Apocynaceae) Genus of lianes and climbing, woody plants with simple leaves, held in whorls, or opposite. The sap is a milky latex. The regular, often showy and fragrant flowers are held in a cyme. The calyx is fused into a tube. The corolla is also tubed, but has five lobes. The five stamens are also fused. The fruits are held in pairs. There are 100 species, found in rain forests in SE Asia, Australia, and New Zealand, 15 of the species being represented in Australia.

Parthenocissus (Virginia creeper; family Vitaceae) Family of deciduous climbing shrubs. The plant clings by means of branched tendrils with sucker-like tips and has palmately compound leaves. The tiny flowers have five petals and grow in clusters. There are 10 species, of which *P. tricuspidata* from the Far East and *P. quinquefolia* from N. America are grown as ornamentals for their attractive red autumn foliage.

parthenogenesis Development of an individual from an egg without fertilization. It occurs in some groups of animals (e.g. flatworms, leeches, aphids, rotifers), in which males may be absent, and plants (e.g. dandelion). The eggs (ova) that develop in this way are usually diploid, so all offspring are genetically identical with the parent. Commonly parthenogenesis with only females in the population alternates with ordinary sexual reproduction, which allows the recombination of genetic material and presents a need for males. This alternation is called heterogamy.

partial dominance In genetics, incomplete or semidominance; the production of an intermediate phenotype in individuals heterozygous for the gene concerned. For example, in *Mirabilis jalapa* (the four-o'clock plant), individuals with red petals bred in a pure line when crossed to a pure line with white petals will yield individuals with pink petals in the first filial generation. The red phenotype (and its determining allele) is said to be incompletely dominant over the white phenotype (and its allele). The impact of a gene at the level of the phenotype depends on its dominance relations, but also on the conditions of the rest of the genome and on the conditions of the environment. *See also* penetrance.

partial parasite *See* parasitism.

partial random sample *See* stratified random sample.

partial rosette plant *See* hemicryptophyte.

partial veil Membranous structure connecting the edge of the pileus to the stipe in the immature fruit bodies of certain agarics.

particle density The mass per unit volume of soil particles, usually expressed in grams per cubic centimetre. *Compare* bulk density.

partridge cane *See Rhapis*.

partridges **1** *See Alectoris*; *Perdix*; and Phasianidae. **2** (tree partridge) *See Arborophila*.

partridge wood Oak wood that has been subjected to a pocket rot caused by *Stereum frustulatum*.

Parulidae (New World warblers; order Passeriformes) Family of small birds which are mainly olive and grey, but which are boldly patterned with other colours. They have slender, pointed bills; medium-sized, pointed wings with nine primaries; and medium-length tails. They are mainly arboreal, some climbing trees; others are terrestrial. Many are migratory. They inhabit forests and brush; feed on insects, nectar, and fruit; and nest in bushes, trees, and on the ground. There are about 25 genera, with 126 species, found in N., C., and S. America, and the W. Indies.

Parus (tits, chickadees; family Paridae) Genus of small, olive, brown, or grey birds which have yellow, white, or buff under-parts. Many have black caps and bibs, some have crests. Many frequent gardens, readily using nestboxes. They feed particularly on nuts, which many store. There are 47 species found in Europe, Africa, Asia, and N. and C. America.

pasang (*Capra aegagrus*) *See* Bovidae.

Passalidae (class Insecta, order Coleoptera) Family of large, shiny, flattened beetles, 20–60 mm long,

which have an elongate, parallel-sided body, which is usually black or brown. The antennae are curved and comb-like. They are found under bark in tropical forests. They regurgitate chewed wood to feed larvae. It is claimed that adults of both sexes tend larvae to maturity. Larvae are curved and fleshy, with much reduced back legs. Adults and larvae stridulate. There are 490 species, none occurring in Europe.

passenger pigeon (*Ectopistes migratorius*) *See* Columbidae.

Passer (sparrows; family Ploceidae) Genus of small, mainly brown and grey birds, in which the males have black throats and chins. They inhabit woodland, grassland, desert, and urban areas; feed on seeds and insects; and nest in trees, bushes, and buildings, often communally. *P. domesticus* (house sparrow) is particularly associated with humans and has been introduced to N. and S. America, S. Africa, Australia, and New Zealand. There are 18 species found, other than introductions, in Europe, Africa, and Asia.

Passer domesticus (house sparrow) *See Passer.*

Passeriformes (perching birds, passerines; class Aves) Order of small to medium-sized birds which have widely varied plumage and shape. The bill is modified for a range of feeding habits. The feet have three toes pointing forward and one backward which assists perching. Nests can be simple or elaborate. Young are usually naked at hatching. Passerines can be terrestrial, aerial, or arboreal. The order is divided into 82 families, and contains more than 5000 species, 60% of the class. They are found worldwide.

Passerina (buntings; family Cardinalidae) Genus of blue, yellow, red, and purple, finch-like birds, the females of which are brown or green. They inhabit forest edges and open country, feed on seeds and insects, and nest in trees. Their colourful plumage makes them popular cagebirds. There are six species, found in N. and C. America.

passerine Member of the order Passeriformes (perching birds), which have four toes, the hallux forming the hind toe which is not reversible and is well developed to assist perching. All other avian orders can be called non-passerines.

Passifloraceae (passion flowers, grandillas) Family of dicotyledonous shrubs and herbs, most of them climbers with tendrils which arise from the leaf axils and correspond to sterile flower stalks. They have entire or lobed leaves, with small stipules, and glandular petioles. The flowers are regular, and usually bisexual. There are five, overlapping, persistent sepals, sometimes basally fused. The five petals are rarely absent, and are overlapping and often basally fused. There may be a circle, or corona, of petal-like or stamen-like growths inside the corolla. There are five or more stamens held opposite the petals, sometimes in bundles. The ovary is superior and unilocular, with many ovules. The styles are united, with 3–5 stigmas. The fruit is a berry or capsule, and is indehiscent, containing many seeds, each with a large embryo, fleshy endosperm, and surrounded by a pulpy aril. Several species are cultivated either for their showy flowers, e.g. *Passiflora caerula*, which is an indoor (or delicate outdoor) climber in Britain, or for the edible fruits, e.g. *P. quadrangularis*, which is cultivated in the tropics. *P. edulis* is the passion fruit or purple granadilla of Asia and Australia. There are 20 genera, with more than 600 species, found in all tropical regions but especially in America and Africa.

Passiflora edulis (passion fruit, purple granadilla) *See* Passifloraceae.

passion flowers *See* Passifloraceae.

passion fruit *See* Passifloraceae.

Passites *See* Anthophoridae.

passive immunity Immunity against a given disease acquired by the injection into the host of serum containing antibodies that have been formed by a donor organism itself possessing active immunity to the disease.

Pasteurella Genus of bacteria not assigned to a taxonomic family. The cells are Gram-negative, ovoid or rod-shaped, and non-motile. They are chemo-organotrophic, and found as parasites in animals, including humans, and birds; they can cause disease. (The causal agent of plague, formerly called *Pasteurella pestis*, is now regarded as a species of *Yersinia*.)

Pastinaca (parsnip; family Umbelliferae) Genus of plants with pinnate leaves, compound umbels, and either no bracts or bracteoles, or one or two that soon fall. The fruits are ovoid and dorsally compressed, with winged margins. There are about 15 species, in temperate Eurasia and N. Africa. Cultivated forms have been developed with succulent, edible tap-roots.

past-natural *See* natural.

pastoralism Human way of life that depends economically largely upon grazing domesticated animals (e.g. cattle, sheep, goats) or semi-domesticated animals (e.g. reindeer), which provide food, clothing, hides used to make shelters, etc. Often the number of stock owned by an individual herdsman is a measure of his wealth and social status. Some seasonal migration is often associated with pastoralism, so that pastoralists are often semi-nomadic.

pasturage (common of) The right to graze animals, usually sheep, goats, cattle, horses, or geese, on common land.

Pataecidae (prowfish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish which have a scaleless, smooth body, and a very long dorsal fin extending from the head to the tip of the tail. The body is deep in the head region, but tapers down sharply toward the tail. Occurring in temperate Australian waters, several species, including *Aetapcus vincenti* (smooth prowfish), which grows to 15 cm, are caught occasionally by anglers or in trawler nets. There are at least four species.

patagium In Mammalia, a fold of skin between the fore and hind limbs; it is used in gliding or flying.

Patagonian floral region Part of Good's (1974) Antarctic kingdom: it has a small flora with a modest number of endemic genera. It comprises the lowland regions of the extremities of S. America. The Falkland Islands (Malvinas) are also included, but despite their isolation they have no well-known endemic genera. There are clear relationships with the flora of New Zealand.

Patagonian hare (*Dolichotis*) *See* Caviidae.

patch reef *See* reef.

patella The knee-cap. In most Mammalia, and in some Aves and Reptilia, a bone located in front of the knee joint in the hind limb and set in a tendon of the muscles which straighten the limb.

'patella' beach Old term referring to a raised beach standing about 3 m above the present high-water mark and found locally on the S. coast of England, in S. and W. Ireland, and along the Channel coast of France. Traditionally it was given an interglacial age, but now it is little used as a term, owing to problems of correlation. It is named after the large number of limpets (*Patella vulgata* is the common limpet) it typically contains.

Patella vulgata (limpet) *See* Archaeogastropoda.

Paterinida (class Inarticulata) Extinct order of brachiopods, which had rounded or elliptical, phosphatic shells. Both valves were convex to hemiconical. The pedicle probably emerged between the valves. Paterinida range in age from Lower Cambrian to Middle Ordovician. The order comprises four genera.

paternoster lake Body of water in a formerly glaciated environment that is aligned with its neighbours, so that it appears like a paternoster in a rosary. It is caused by irregular glacial scouring along a zone of weakness.

Patersonia (family Iridaceae) Genus of lily-like herbs found in arid conditions, usually as a component of heath or grass communities. There are 20 species, of which all but three are endemic to Australia and Tasmania. The others are also present in Malaysia.

pathogen Any micro-organism capable of causing disease.

pathogenesis The process of disease development.

pathognomonic Applied to symptoms that are characteristic of a particular disease and that may therefore be useful in diagnosis.

pattern analysis Any analysis for the detection of a non-random distribution of organisms, e.g. nearest-neighbour analysis, or classification techniques. However, the term is applied more particularly to the detection of patterns in the distribution of individuals of a given plant species in a community, by comparing the observed number of individuals per quadrat with the expected number derived from the Poisson series (based on a population that is dispersed at random). The correspondence is tested for statistical significance either by comparing observed numbers with those predicted using the χ^2 test, or by comparing the variance : mean ratio for the data with the value for the Poisson series of unity. Where this ratio is significantly greater or less than unity, the population is respectively overdispersed (contagious) or underdispersed (regular). Though first applied to studies of plant ecology, the technique is now widely used in other fields.

patterned ground General term describing an assemblage of small-scale, regular features that have developed at or near the ground surface and present a geometric appearance. It is characteristic of periglacial areas where stone circles and stripes are typical forms. Both appear due to the sorting action of ice growth in the regolith, the circles being elongated into stripes as the gradient increases. It is also found in areas of montmorillonitic soils experiencing markedly seasonal rainfall, where the microrelief forms are called 'gilgai'.

Paulownia (family Scrophulariaceae) Genus of small trees which have foxglove-like flowers, and are widely grown as ornamentals. Sucker shoots bear enormous leaves. There are 17 species, occurring in E. Asia.

Paurotis *See Acoelorraphe*.

Pavlov, Ivan Petrovich (1849–1936) Russian physiologist, renowned for his research into blood circulation, digestion (for which he was awarded the 1904 Nobel Prize), and conditioned behaviour in animals. From 1928 until his death he concentrated on the application of the principles of conditioning to psychiatric therapy. His approach to his behavioural work was based on the application of objective experiment to mental processes and the rejection of the mind–body dualism characteristic of earlier psychological studies.

pawpaw *Asimina triloba*. *See* Annonaceae.

Paxillaceae (order Agaricales) Family of fungi in which the spores in masses appear yellowish-brown to olive-brown. The pileus and stipe (when present) are confluent, and the gills separate readily from the pileus. There are several genera, found growing on soil, wood, etc.

paxillae *See* Diplozonina.

Paxillosida (starfish; class Stelleroidea, subclass Asteroidea) Order of starfish in which the plates surrounding the peristome (mouth-angle plates) are large and derived from fused ambulacral ossicles. Marginal ossicles are not invariably developed, but commonly bear dorsoventral, intermarginal fascioles. The marginals are separated from the mouth frame by small, oral, intermediate ossicles. The order is known from the Ordovician to Recent.

Payena (family Sapotaceae) Genus of small to large forest trees in which the leaves are alternate. They yield hard, heavy, sometimes siliceous timber (nyatoh). There are 16 species, occurring from Burma to the Philippines.

pea 1 (garden pea) *See Pisum*. 2 (wild pea, sweet pea) *See Lathyrus*. 3 (Sturt's desert pea, *Clianthus formosus*) *See Clianthus*.

peach *See Amygdalus*.

peach-leaf curl Disease which affects not only peach trees but also nectarines, almonds, and (less often) apricots. The characteristic symptoms are the curling, thickening, and distortion of the leaves which typically become bright red. The disease is caused by a fungus, *Taphrina deformans*.

peacock butterfly *See Inachis io*.

peacock ore *See* bornite.

peanut (*Arachis hypogaea*) *See Arachis*.

peanut worms *See* Sipunculida.

pear *See Pyrus*.

pearleye *See* Scopelarchidae.

pearlfish *See* Carapidae.

pearl-necklace lightning (chain lightning, beaded lightning) Infrequent type of discharge, in which variations in luminosity appear as pearls on a string.

pearl perch (*Glaucosoma scapulare*) *See* Glaucosomidae.

pearl spar *See* dolomite.

pear midge (*Contarinia pyrivora*) *See* Cecidomyidae.

pear moss Common name for the moss *Physocomitrum pyriforme* (order Funariales). The name derives from the characteristic pear-shaped capsules formed in spring; the shoots are small (to 5 mm tall) and inconspicuous. Pear moss is found on damp ground and on mud, on roadsides, by ditches, on river banks, etc.

peat An organic soil or deposit; in Britain, a soil with an O horizon at least 40 cm thick. Peat formation occurs when decomposition is slow owing to anaerobic conditions associated with waterlogging. Decomposition of cellulose and hemicellulose is particularly slow for *Sphagnum* plants, which are characteristic of such sites, and hence among the principal peat-forming plants. Fen and bog peats differ considerably. In fen peats the presence of calcium in the ground water neutralizes acidity, often leading to the disappearance of plant structure, giving a black, structureless peat. Bog peats, formed in much more acidic waters, vary according to the main plants involved. Species identification of constituents (including those of animals as well as of plants) remains possible after long periods. Recent bog-moss (*Sphagnum*) peat is light in colour, with the structure of the mosses perfectly preserved.

peat-borer Implement designed to extract peat cores with the minimum of disturbance. The most familiar is the Hiller peat-borer, which consists of a short screw auger head to ease penetration of the peat, backed by a chamber which can be opened and closed at the required sample depth, the sharp cutting edge of the chamber assisting detachment of the sample in more consolidated peats. The principal alternatives are the piston sampler, which is particularly good for loose peats, and the Russian borer, which allows easier removal of the complete peat core than is possible with the Hiller borer, but which is more difficult to use in compacted peats since it has no screw auger head.

peat moss Common name for a moss of the genus *Sphagnum*, common on wet peat.

peat podzol Podzol soil profile distinguished by having a surface mor (peaty) humus up to a maximum thickness of 30 cm, and usually with an iron pan at the top of the B horizons. The term occurs in most of the classification systems derived originally from the work of V. V. Dokuchaev, published in 1886. It has been superceded by the USDA Soil Taxonomy, where podzols fall within the order Spodosols.

pea weevil (*Sitona lineatus*) *See* Curculionidae.

pebrine Disease of the silkworm (*Bombyx mori*), caused by the protozoon *Nosema bombycis*. The disease is usually fatal.

pecan *See Carya*.

peccary (*Tayassu*) *See* Tayassuidae.

pecking order Name given to the hierarchical social organization found in some insect species, e.g. ants, bees, and in many vertebrate species. It is so called because the phenomenon was first described for chickens. Social organizations of this type have survival value, e.g. clustering in bees generates and maintains sufficient warmth to ensure survival during winter temperatures low enough to kill the same individuals if isolated. Colonies may also have a regulatory function operating against growth in excess of immediate environmental resources.

Pecora (cattle; order Artiodactyla, suborder Ruminantia) Infra-order comprising the three superfamilies Traguloidea (chevrotains), Cervoidea (deer and giraffes), and Bovoidea (antelopes, cattle, goats, sheep, etc.). These form the most recent ungulate group, known since the Miocene, and are the most advanced of ruminants. The stomach is four-chambered, the upper incisors and in some forms the upper canines are absent, and the molars are selenodont. Only two digits are functional on each limb. Most members possess horns: these may be present only in the male, and used principally for intraspecific fighting; they are developed in some forms for ritualized contests that seldom cause injury. Tragulids possess enlarged upper canines which are used in defence.

pectin One of a group of homopolysaccharides that contain a variety of monosaccharides, but that are especially rich in galacturonic acid. They form a kind of cement, so contributing to the structure of plant cell walls, being particularly abundant in young primary walls and fruits.

pectinate Resembling a comb in arrangement or shape.

pectine In Scorpiones, a sensory appendage composed of three chitinous plates forming an axis attached by its centre to the second abdominal segment near the ventral midline, below which toothlike processes are suspended, so that the whole structure resembles a comb.

pectinibranch Applied to the type of gill structure, common in the order Mesogastropoda, in which only one—very efficient—gill is present.

pectinolytic Capable of digesting pectin, the material that acts as a kind of cement between the cells of higher plants.

pectocaulus *See* Rhabdopleurida.

pectoral fin In fish, one of the pair of fins that are situated one on each side of the fish just behind the gills ('breast fins'). Normally they are used for balancing and braking, but in some species, e.g. Exoceutidae (flying fish), the extra-large fins are used for jumping and for gliding over the water surface.

pectoral girdle In vertebrates, the skeletal structure that provides support for the fore-limbs or fins.

ped Unit of soil structure (e.g. an aggregate, crumb, granule, or prism) that is formed naturally. *Compare* clod.

Pedaliaceae (sesames) Family of annual and perennial herbs, and some shrubs, which have opposite, simple, or lobed leaves, without stipules but often with glandular hairs. The flowers are either solitary, or in small, axillary cymes, usually three-flowered. They are irregular and bisexual, with a united calyx and a tubular corolla, each composed of five parts. The four stamens are paired, and attached to the petals. The ovary is superior, with two fused carpels and a long style with two stigmas. There are 2–4 locules, with several ovules. The fruit is a nut or capsule, often hooked on the surface. The seeds contain little endosperm. Some species of the genus *Sesamum* provide edible seeds and oil (sesame). *S. indicum* is widely cultivated in India for its seeds. There are 12 genera, with 50 species, found in arid and saline habitats in Africa, Australia, S. India, and Malaysia.

Pedetidae (Cape jumping hare; order Rodentia, suborder Sciuromorpha) Family of rabbit-like, burrowing or terrestrial, nocturnal rodents which move by hopping or leaping. The ears are long and can be closed by rolling the pinna during digging, the hind limbs are long and modified for jumping, the forelimbs are short and possess long claws. There are five digits on the forelimbs and four on the hind limbs. The tail is long, and covered with long hair. Pedetidae are distributed through C. and S. Africa. There is one genus, *Pedetes*, and one species.

pedicel 1 The stalk of one flower in an inflorescence. 2 In Araneae, the short, narrow portion of the body that connects the prosoma with the abdomen.

pedicellariae In some Echinodermata, minute, stalked organs each consisting of a stem with a movable head built of three jaw-like valves and attached to small tubercles on the tests. They are used for grasping, defence, and scavenging. In many species they inject venom.

pedicle *See* Brachiopoda.

Pediculati Older name for the group of fish now placed in the order Lophiiformes.

Pediculidae (order Phthiraptera, suborder Anoplura) Family of sucking lice, which are parasitic on some primates, including humans. The single genus, *Pediculus*, contains four species, two parasitic on humans, one on the chimpanzee, and one on spider monkeys (*Ateles* species). The two species parasitic on humans, *P. humanus* and *P. capitis*, have sometimes been considered two subspecies of a single species, but they differ in the relative lengths of parts of their legs, and in the environment they use. *P. humanus* lives and lays its eggs on human clothing, moving on to the body to feed; whilst *P. capitis* lives and lays its eggs on the hair of the scalp, and can cause mechanized dandruff. *P. humanus* is a vector of typhus, European relapsing fever, and trench fever, and because of this has been responsible for millions of human deaths. *P. capitis* is not known to transmit any diseases in natural conditions.

Pediculus capitis (human head louse, cootie, mechanized dandruff) *See* Pediculidae.

Pediculus humanus (human body louse, clothing louse) *See* Pediculidae.

pediment Surface of low relief, partly covered by a skin of rock debris, that slopes at a low angle (normally less than 5°) from the base of a mountain zone or scarp. Classically it is developed and has been investigated in the arid and semi-arid regions of the western USA.

Pedinoida (class Echinoidea, superorder Diadematacea) Order of regular echinoids, of subconical to depressed hemispherical shape, which have simple or compounded, diadematoid, ambulacral plates, and shallow slits notching the peristomal margin for the passage of gills. They first appeared in the Triassic.

Pedionomidae (plains-wanderer; order Gruiformes) A monotypic family, *Pedionomus torquatus* is a small, quail-like bird, mainly brown, with loose plumage. It has a neck longer than those of quails, and tends to stand up erect. Its feet have a hind toe. A terrestrial species, rarely flying, it is found in open grassland, feeds on insects and seeds, and nests on the ground. It is confined to Australia.

Pedionomus torquatus (plains-wanderer) *See* Pedionomidae.

Pedipalpi (class Arachnida) Arachnid order in which the Uropygi (including Schizomida) and Amblypygi are often combined as suborders because of their similarities. All members are strikingly flattened (an adaptation for living in confined spaces) and have the first walking leg modified as a slender whip. The seventh body segment is constricted to form a pedicel, and there are two pairs of book lungs. There are nevertheless two distinct groups, the scorpion-like Uropygi which have a terminal flagellum, and the spider-like, tailless whipscorpions (amblypygids).

pedipalps In Arachnida, the second of the six pairs of appendages possessed by the prosoma. They have become walking legs, or true palps, in those arachnids that have large chelicerae (Araneae, Palpigradi, Solifugae, and many Opiliones and mites). In orders with small chelicerae (Scorpiones, Amblypygi, Uropygi, and Pseudoscorpiones) the

pedipalp has become modified to form a large raptorial organ. The pedipalps are universal tools for the killing and manipulation of prey, as well as for defence and digging. In all arachnids they also serve as tactile and olfactory organs. In the spiders, the pedipalps guide food into the mouth, and the pedipalpal tarsus has become modified in males to form a complex copulatory structure (often used by taxonomists as a means of species identification).

pediplain Extensive plain, best developed in arid and semi-arid regions, showing gently concave or straight-slope profiles and terminated abruptly by uplands. A result of scarp recession rather than of surface lowering, it consists of coalesced pediments.

pedogenesis Natural process of soil formation, including a variety of subsidiary processes such as humification, weathering, leaching, and calcification.

pedology Scientific discipline devoted to the study of the composition, distribution, and formation of soils, as they occur naturally.

pedon Three-dimensional sampling unit of soil, with depth to the parent material and lateral dimensions great enough to allow the study of all horizon shapes and intergrades below the surface.

peduncle 1 The inflorescence stalk of a plant. 2 *See* Brachiopoda. 3 (caudal) Section of the body of a fish between the anal fin and the origin of the tail-fin; a 'tail stalk'.

Pegasidae (dragonfish, sea moth; class Osteichthyes, subclass Actinopterygii, order Pegasiformes) Small family of marine fish, which have oddly-shaped bodies encased by a bony armour, large, wing-like, pectoral fins, and a produced snout. *Pegasus volitans*, growing to 15 cm, is a typical member of the family and is widely distributed in warmer waters of the Indo-Pacific region. There are about five species.

Pegasiformes Order of bony fish including only the family Pegasidae.

pegmatite Very coarse-grained, igneous rock, often of granitic composition, in which the individual crystals are more than 3 cm, and may reach more than 1 m in length. Pegmatites may concentrate some rare elements to economic proportions.

pelage The hair covering the body of a mammal.

pelagic 1 In marine ecology, applied to the organisms that inhabit open water, i.e. plankton, nekton, and neuston (although neuston are fairly unimportant in such environments). 2 In ornithology, applied to seabirds that come to land only to breed, and that spend the major part of their lives far out to sea.

pelagic ooze Deep-ocean sediments that accumulate by the settling out of materials from the overlying ocean waters. The dominant constituents are microscopic pelagic organisms, e.g. the calcareous *Globigerina* and pteropods, and the siliceous diatoms and radiolaria. Minor amounts of fine volcanic, terrigenous, and extraterrestrial debris also contribute to pelagic ooze.

Pelargonium *See* Geraniaceae.

Pelecanidae (pelicans; order Pelecaniformes) Family of large, white, brown, or grey birds which have long, broad wings; short tails; and a long, broad bill, the lower mandible of which has a large, distensible pouch. The feet are totipalmate. Pelicans inhabit estuaries and inland and coastal waters, feed on fish and crustaceans, and nest colonially in trees or on the ground. There is one genus, *Pelecanus*, with eight species, found in S. Europe, Africa, Asia, Australia, and N., C., and S. America.

Pelecaniformes (tropicbirds, pelicans, gannets, cormorants, frigatebirds, anhingas; class Aves) Order of diverse, mainly marine birds, most of which have large bills and bare skin on the throat, which is distensible in some. They have short legs, the feet being totipalmate, but only basally in *Fregata* species. They are good fliers and swimmers, diving for food from the air or water surface, and feeding on fish and crustaceans. Most nest on cliffs or in trees. There are six families: Anhingidae, Fregatidae, Pelecanidae, Phaethontidae, Phalacrocoracidae, and Sulidae. They are found worldwide.

Pelecanoides (diving petrels) *See* Pelecanoididae.

Pelecanoididae (diving petrels; order Procellariiformes) Family of stocky, short-necked, short-winged petrels which have short bills and nostrils open at the top. They have a whirring flight, can dive into the sea, and can swim well under water to catch crustaceans. They breed in burrows on sub-antarctic islands, and are less pelagic than most petrels. There is one genus, *Pelecanoides*, with four species, found in the southern oceans.

Pelecanus (pelicans) *See* Pelecanidae.

Pelecypoda (Bivalvia, Lamellibranchia; phylum Mollusca) Class of molluscs in which the body is laterally compressed, there is no definite head, and the soft parts are enclosed between two oval or elongated, calcareous valves. The valves are not equilateral, being united on the dorsal side by a toothed hinge. Most are bilaterally symmetrical along the plane of junction of the two valves. The valves are closed ventrally by the contraction of one or two adductor muscles, and opened by a horny, elastic ligament. Large, modified, ciliated gills combine with ciliated labial palps in food collection. The stomach is extremely elaborate, with a crystalline style. The circulatory, excretory, and reproductive systems are less complex. There is a ganglionic nervous system. Inhalant and exhalant siphons are present. Trochosphere and veliger larvae are produced by marine forms. The sexes are generally separate; some are hermaphroditic and protandrous. Pelecypods are entirely aquatic and are adapted to various modes of life, as burrowing, boring, sessile, and free-living organisms. They appeared first in the Lower Cambrian and form the second largest molluscan class, with more than 20 000 species.

pelicans *See* Pelecanidae; and Pelecaniformes.

pellagra *See* nicotinic acid.

Pellia (order Metzgeriales, class Hepaticae) Genus of thallose liverworts, which includes *P. epiphylla*,

one of the commonest and most conspicuous of all liverworts, and often studied as a representative of this group of plants in elementary botany courses. The thallus is robust, several centimetres long and up to 1 cm across. It has an ill-defined midrib, and is irregularly branched, often spreading to form extensive carpets. Older parts are dark green, while the growing tips are pale green. *Pellia* species are found on moist banks by ditches and streams, also on damp peat in heaths, moors, and on mountains.

pellicle 1 Layered structure which surrounds the cells in many types of protozoa. 2 Flexible protein layer which surrounds the cytoplasm in algae of the genus *Euglena*.

pelma *See* Pelmatozoa.

Pelmatozoa (phylum Echinodermata) Group ranked by some authorities as a subphylum; but often the term is used only informally to describe attached echinoderms, which usually have a stalk (pelma). The group includes the subphyla Homalozoa and Crinozoa. Pelmatozoans have radial symmetry, consisting of a globoid, plated test (or theca, or calyx) attached by a stalk inserted on the aboral surface. Ambulacra, restricted to the oral surface, act as food grooves which are extended on to projecting appendages (arms or brachioles). Pelmatozoa first appeared in the Lower Cambrian.

Pelobates fuscus (spadefoot toad, garlic toad; order Anura (Salientia), family Pelobatidae) Species of burrowing toad in which females are up to 8 cm long, the males being smaller. The skin is smooth, or with small warts, and has brown and red markings. The hind feet have large, sharp, horny growths for digging. The species occurs in E. Europe and W. Asia.

Pelobatidae (spadefoot toads, horned frogs; order Anura (Salientia), suborder Anomocoela) Family of amphibians which have no ribs, minute teeth, and digging tubercles developed on their hind feet. They are adapted to dry habitats, appearing on the surface only after rain. Metamorphosis is rapid. There are 54 species, occurring in N. America, Eurasia, and N. Africa.

Pelomedusidae (hidden-necked turtles; order Chelonia (Testudines), suborder Pleurodira) Family of freshwater turtles, in which there is some vertical bending of the neck in withdrawal before the head is laid to the side. They are omnivores in shallow water, but may travel over land. There are 14 species, occurring in S. America, Africa, and Madagascar.

Peloridiidae (class Insecta, order Hemiptera) Family of bugs which have characteristics of both Hemipteran suborders. They are said to feed on mosses. The forewings have reticulate venation, and both they and the hindwings are almost always reduced to a condition where flight is impossible. They are restricted to temperate regions of the southern hemisphere.

peltate Shield-shaped, having a central rather than a lateral stalk.

Peltigera (family Peltigeraceae) Genus of lichens, in which the thallus is foliose and often large. The lower surface is loosely downy, and marked with more or less prominent, vein-like ridges. The phycobiont may be a green alga or a cyanobacterium, according to species. Apothecia are formed on the upper surface at the edges of the thallus. The spores are multiseptate, and colourless or pale brown. They are found on the ground or on mosses, trees, rocks, etc.

Peltigeraceae (order Lecanorales) Family of lichens, in which the thallus is foliose with a cortex on the upper surface and often also on parts of the lower surface. The lower surface is often marked with vein-like ridges, and may or may not bear rhizines. The asci turn blue when treated with iodine. Spores have two or more transverse septa, and are colourless to brown. There are three genera, found on the ground and on other substrates.

Pelvetia (family Fucaceae) Genus of brown seaweeds, in which the thallus differs from that of *Fucus* species in having no midrib, and from that of *Ascophyllum* in having no air bladders. The only British species is *P. canaliculata* (*see* channelled wrack).

pelvic fin One of the pair of fins positioned on the underside of the body of a fish. Depending on the species, the pelvic or ventral fins can be found in a mid-ventral (abdominal) position, underneath or just behind the pectoral fins (thoracic position), or in front of the pectorals in the throat region (jugular position).

pelvis 1 In vertebrates, the skeletal structure that provides support for the hind limbs or fins. 2 The part of the abdomen that is surrounded by the bony pelvis.

Pelycosauria Order of synapsid reptiles dating from the Upper Carboniferous and Lower Permian. Several sported large, sail-like, dorsal fins, and both carnivorous and herbivorous types appeared. They gave rise to and were replaced by the mammal-like reptiles (therapsids).

Pempheridae (sweeper, bullseye; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have a fairly deep body, a short dorsal fin, a long-based anal fin, and large eyes. They are mostly schooling, shallow-water species found near caves, rock ledges, etc., and are well known to divers. Most species have an orange-red colour. These include *Liopempheris multiradiata* (common bullseye), 20 cm, of temperate Australian waters. There are about 20 species, distributed worldwide.

Pemphis (family Lythraceae) Genus of small trees or shrubs, which comprises two species. *P. acidula* occurs on abrading coasts from Africa to the Pacific, and *P. madagascariensis* in the wet mountains of Madagascar.

pencil fish (*Nannostomus marginatus*) *See* Lebiasinidae.

penduline tits *See* Remizidae.

Penelope (guans; family Cracidae) Genus of medium to large, long-necked, long-tailed birds, in

which the throat is bare and red, with the skin hanging down; the skin around the eyes is bare; and crown feathers form a small crest. Guans are mainly brown, chestnut, and grey, with one species, *P. albipennis* (white-winged guan) having white primaries. They live in rain forest, feed on vegetable matter, and nest in trees. There are 15 species, found in C. and S. America.

Penelope albipennis (white-winged guan) *See Penelope*.

peneplain Literally, almost a plain: an extensive area of low relief, dominated by convex-up ('bulging') hillslopes mantled by a continuous regolith, and by wide, shallow river valleys. Locally monadnocks may occur. A peneplain is the end-product of a cycle of erosion, produced by the action of down-wearing over a long period of time.

penetrance The proportion of individuals of a specified genotype who manifest that genotype in the phenotype under a defined set of environmental conditions. If all individuals carrying a lethal mutation die prematurely, then the mutant gene is said to show complete penetrance. An organism may not express the phenotype normally associated with its genotype because of the presence of modifiers, epistatic genes, or suppressors in the rest of the genome; or because of a modifying effect of the environment. Expressivity describes the degree or extent to which a given genotype is expressed phenotypically in an individual.

penguins *See* Spheniscidae.

penicillin Type of antibiotic produced for example by fungi of the genus *Penicillium*. Penicillins are active against certain types of bacteria (mainly Gram-positive species) and are widely used in the treatment of diseases caused by those bacteria. (Pencillin G was one of the first antibiotics to be used for the treatment of disease.) There is now a wide range of chemically-modified penicillins, each with slightly different properties. They function by inhibiting the synthesis of bacterial cell walls.

Penicillium (class Hyphomycetes) Form-genus of fungi which form branched conidiophores bearing phialids. Conidia appear as greyish-green or bluish-green powdery masses on white mycelium. Most species are saprotrophic and cosmopolitan in distribution. Many species produce important antibiotics, including penicillins. Some species are used in the manufacture of certain types of cheese.

Peniculina (order Hymenostomatida) Suborder of ciliate protozoa in which characteristic bands of cilia, comprising the so-called peniculus, occur in the cytopharyngeal region. Body cilia are arranged uniformly. There are several families, including the well-known genus *Paramecium*, found in aquatic environments.

Pennatulacea (sea-pens; subclass Octocorallia) Order of colonial octocorals with an elongate primary polyp embedded in mud on the sea-bottom. The distal end of the primary polyp bears secondary polyps, usually on lateral branches. The polyps are supported by a calcareous or horny skeleton. They are known first as fossils from Cretaceous and Tertiary strata, and with uncertainty from the Silurian. The order contains two suborders, 14 families, and about 40 genera.

Pennsylvanian *See* Carboniferous.

Pentaceropsis recurvirostris (long-snouted boarfish) *See* Pentacerotidae.

Pentacerotidae (Histiopteridae; boarfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, deep-bodied fish which have a steep forehead, a produced snout, and a small mouth. The dorsal fin is composed of strong spines as well as soft fin-rays. Pentacerotidae are usually found in deeper waters offshore and inhabit warm to temperate waters between S. Africa and the E. Pacific coast. Several species are fairly common in trawl catches off S. Australia and are considered good eating, including *Pentaceropsis recurvirostris* (long-snouted boarfish). There are about 12 species.

pentacrinoid In some Crinoidea, applied to a sessile, stalked larva, whose crown eventually detaches itself to become the adult free-swimming form.

pentadactyl Applied to a limb possessing five digits, or to one modified evolutionarily from an ancestral form which possessed five digits; characteristic of all tetrapods.

pen-tailed tree shrew (*Ptilocercus*) *See* Proteutheria.

Pentamerida (class Articulata) Extinct order of brachiopods, with thick, strongly biconvex shells. A spondylium developed in the pedicle valve and brachial processes and supporting plates in the brachial valve, forming an internal calcareous box containing the adductor muscles (which close the valves) and diductor muscles (which open the valves). The shell is impunctate. Pentamerida first appeared in the Middle Cambrian and became extinct in the Upper Devonian. The order comprises 17 families, with 80 genera.

pentamerous Of a flower, with parts in fives. This is the most typical arrangement of dicotyledons.

Pentaphylax (family Pentaphylacaceae) Genus of small, bushy trees, which have small, regular, hermaphrodite, pentamerous flowers, porous anthers, and whose fruit is a capsule. They are related to Theaceae. There is one species, occurring from S. China to Malaya and Sumatra.

Pentapodidae (large-eye bream; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish related to the Lethrinidae. They are deep-bodied, oval-shaped, and have a continuous dorsal fin, a forked tail-fin, and large eyes. The greenish body often shows stripes, bars or spots. Several species, including *Gymnocranius griseus* (grey large-eye bream), 60 cm, are regularly marketed in a number of countries in SE Asia. Some authors have placed the fish in the family Lethrinidae, others in the Nemipteridae. There are about nine species, occurring in the Indo-Pacific region.

Pentatomidae (shieldbugs; order Hemiptera, suborder Heteroptera) Family of bugs in which the scutellum is large and in some forms almost completely covers the forewings and abdomen. A group of a few hundred species are predators, the rest feed on plants. In late summer they are often found feeding on wild berries. There are 5000 species, found in most parts of the world, but they are especially numerous in the tropics.

pentlandite Mineral, specific gravity 4.5–5.0, hardness 3.0–4.0, chemical composition $(FeNi)_9S_8$. It occurs with other sulphide ores genetically associated with basic and ultrabasic rocks, and together with pyrrhotine and chalcopyrite. It is light bronze-yellow and has a greenish-black streak, and a metallic lustre. It crystallizes in the cubic system. It is very rarely found in well-formed crystals, usually occurring as irregular grains and inclusions. It is the main ore mineral for nickel.

pentose Monosaccharide comprised of five carbon atoms.

pentose-phosphate shunt *See* hexose-monophosphate shunt.

Pentoxylales Extinct gymnosperms of Jurassic age, known from India and New Zealand. They probably grew as shrubs or very small trees.

Peodytidae (class Amphibia, order Anura (Salientia), suborder Anomocoela) Family of amphibians: they are related to the spadefoot toads (family Pelobatidae), but possess long, leaping, hind limbs, which lack digging structures. There are two species, found in W. Europe.

peony *See Paeonia*.

Peperomia (family Peperomiaceae) Principal genus of a family of fleshy herbs, some of which are climbing or epiphytic. The leaves are without stipules. Flowers are borne in spikes, and are hermaphrodite, with no sepals or petals, and two stamens. The fruit is a berry. Some species are cultivated for their attractive foliage. There are 1000 species, occurring in the tropics, mainly in America.

pepper Fruit of *Piper nigrans*. *See Piper*.

pepper dulse Common name for the red seaweed *Laurencia pinnatifida* (family Rhodomelaceae, order Ceramiales). The seaweed is variable in form and colour. When growing in bright sunlight on the upper shore, it usually grows in short, dense tufts and is yellowish-green in colour; but when growing further towards the low-water mark it is larger and dark reddish-purple. The plant generally is flattened and extensively branched in one plane. It has a strong, distinctive, pungent smell, and a peppery taste. It has been used as a condiment in some areas.

peppered moth *See Biston betularia*.

peppermint, willow (*Agonis flexuosa*) *See Agonis*.

pepper-shrikes *See* Vireonidae.

Peprilus simillimus (pompano) *See* Stromateidae.

peptide Linear molecule comprising two or more amino acids linked by peptide bonds.

peptidoglycan Amino-acid-containing polysaccharide which forms the rigid component in the cell walls of most bacteria and cyanobacteria. It is never found in eukaryotic cells.

Peptococcaceae Family of bacteria in which the cells are Gram-positive, spherical, and occur singly or in groups of two or more. They are non-motile, chemo-organotrophic, and can grow only in the absence of air. There are several genera, found in the bodies of animals (including humans), in the soil, and in association with cereal grains.

peptone Partially hydrolysed protein used as a nutrient in microbiological culture media.

perambulation 1 The established boundaries of a forest or parish. 2 A legal document that defines an area of land by describing its boundaries.

Perameliidae *See* Perameloidea.

Perameloidea (bandicoot; infraclass Metatheria, order Marsupialia) Superfamily comprising two families, Peramelidae and Thylacomyidae, of mainly insectivorous, burrowing marsupials, in which the marsupium opens toward the rear; the second and third digits of the hind limbs are syndactylous, and the first reduced or absent; and the dentition is polyprotodont; the molars being adapted for grinding. The muzzle is long, pointed, and flexible, and is used for probing in the soil for invertebrates; the hind limbs are long, and the ears are often large. There are eight genera; with about 20 species, distributed throughout Australia, Tasmania, and New Guinea.

Perca fluviatilis (perch) *See* Percidae.

percentage cover *See* cover.

perch *See* Percidae.

perched block Glacially-transported boulder resting on bedrock where it was deposited by melting ice. Some examples are spectacular and gave rise to legends locally.

perching birds *See* Passeriformes.

perchlet *See* Centropomidae.

Percichthyidae (striped bass, Macquarie perch; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of perch-like fish found in tropical and temperate waters. Some species are exclusively marine, others inhabit freshwater systems. One of the most popular and best studied species is *Morone saxatilis* (striped bass), 1 m, of the eastern USA, which undertakes annual migrations from the sea into the rivers to spawn. Probably the largest and best known of Australia's freshwater fish is *Maccullochella peeli* (Murray cod), 1.3 m, a species regarded highly by anglers. There are about 40 species.

Percidae (perch; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of freshwater fish, including the true perch (*Perca fluviatilis*), 45 cm. Usually they possess a fairly deep and fully scaled body, with two separate dorsal fins, a slightly forked tail-fin, and ventral fins located close to the pectoral base. Several members of this northern hemisphere family have been introduced

to other continents. The family includes a number of important food fish, e.g. the perch, and *Stizostedion vitreum* (walleye), 90 cm, which is one of the largest species. There are at least 126 species.

Perciformes Order of perch-like fish. In terms of the number of families belonging to it (about 146), it is by far the largest order of fish. All species possess a spiny-rayed first dorsal fin and a soft-rayed second dorsal fin, with several spines preceding the soft rays of the anal and pelvic fins. The pelvic fins are inserted just behind or in front of the pectoral fins. The scales are usually of the ctenoid type. Representatives include the tiny gobies as well as the giant marlins.

percolation (pedol.) Downward movement of water through soil, especially through soil that is saturated or close to saturation.

Percophididae (class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish with a somewhat depressed head and body, large eyes, and usually two separate dorsal fins. Living at depths of more than 400 m, *Bembrops caudimacula* (25 cm) is distributed in the Indo-Pacific region. There are about 17 species, with worldwide distribution.

Percopsidae (troutperch; class Osteichthyes, subclass Actinopterygii, order Percopsiformes) Small family of freshwater fish, of scientific interest because they are claimed to form a link between the soft-rayed and spiny-rayed fish. *Percopsis omiscomaycus* (troutperch), 20 cm, is widely distributed in N. America, but is of little commercial importance. There are two species.

Percopsiformes Order of bony fish including the family Percopsidae and two other families. *See also* Paracanthopterygii.

Percopsis omiscomaycus (troutperch) *See* Percopsidae.

Perdix (partridges; family Phasianidae) Genus of medium-sized, brown and grey gamebirds, some of which have a chestnut breast marking. The species have different head markings, *P. perdix* (grey partridge) having an orange-brown mask. Partridges are found on open plains and agricultural land; they feed on vegetable matter, and nest on the ground. There are three species, found native in Europe and Asia, and introduced to N. America and New Zealand.

Perdix perdix (grey partridge) *See Perdix*.

peregrine falcon (*Falco peregrinus*) *See Falco*.

pereiopod *See* pereopod.

perennating bud (perennating organ) The vegetative means whereby biennial and perennial plants survive periods of unfavourable conditions. The aerial parts die back to a minimum at the onset of unfavourable conditions, and food for the new shoots of the next growing season is stored in underground organs (e.g. tubers, bulbs, rhizomes), or in buds on the stems of woody plants. Seeds may also be considered perennating organs.

perennating organ *See* perennating bud.

perennial Plant which normally lives for more than two seasons and that, after an initial period, produces flowers annually.

perfect state (mycol.) The sexual state of a fungus, i.e. the state in which sexually-produced spores are formed.

pereon *See* Isopoda.

pereopod (pereiopod) One of the walking limbs of a crustacean.

perforate nostrils Most species of birds have their external nares (nostrils) separated by a septum (imperforate nostrils). Cathartidae (New World vultures) have no septum and the two nostrils are joined (perforate).

pergelic The lowest of the soil-temperature classes for family groupings of soils in the USDA Soil Taxonomy system, applied to soils in temperate regions. The assessment of soil temperature is based on mean annual temperatures, and on differences between mean summer and mean winter temperatures, measured at a depth of 50 cm or at the surface of the underlying rock, whichever is shallower. Higher-temperature classes in temperate region soils are called cryic, frigid, mesic, thermic, and hyperthermic, and in tropical regions the scale from cold to hot is isofrigid, isomesic, isothermic, and isohyperthermic.

Pergidae (sawflies; suborder Symphyta, superfamily Tenthredinoidea) Family of symphytans which are usually less than 10 mm long. The family is large and its members have very diverse habits. In America, larvae feed extensively on oak and hickory. In Australia, species of *Perga* can cause serious defoliation of *Eucalyptus* trees.

perianth 1 Of a flower, the outer covering, composed of the floral leaves, usually an outer greenish calyx, and an inner, brightly coloured corolla. 2 Of a liverwort, a tube-like or purse-like sheath which surrounds the archegonium.

pericardium 1 The membrane surrounding the cavity around the heart. 2 The cavity around the heart.

pericarp The fruit wall, often with three distinct layers, endocarp, mesocarp, and outer exocarp.

pericentric inversion Inversion of a chromosome piece (containing a block of genes) that involves the centromere.

Pericopsis (family Papilionaceae) Small genus of timber trees, which yield extremely attractive and valuable cabinet timbers, notably afrormosia from tropical Africa. There is one species in Asia, and five in Africa.

periderm *See* bark.

peridium The outer wall or membrane which encloses the spores in the fruiting bodies of certain fungi and slime moulds.

periglacial Applied strictly to an area adjacent to a contemporary or Pleistocene glacier, but more generally to any environment where the action of freezing and thawing is currently, or was during the Pleistocene, the dominant surface process.

perignathic girdle Continuous or discontinous ring of internal processes around the peristome of echinoids, where the muscles which support and control the lantern are attached. It is made up of apophyses or auricles.

perigynous Applies to flowers in which the calyx, corolla, and stamens are inserted around the ovary, on a disc-like structure.

perihelion The position in the Earth's eccentric orbit at which the planet is closest to the Sun. During the present epoch this occurs about the beginning of January when the average receipt of solar radiation is at a maximum. *See also* aphelion.

period Second-order geological time unit which is the equivalent of the chronostratigraphical unit 'system'.

peri-oral Applied to the region around the mouth.

periostracum Thin layer of dark-coloured (tanned) protein on the outer surface of brachiopod, pelecypod, and gastropod shells, which protects the growing edge of the shell. Being thin and composed of proteinaceous material, it is not generally preserved in fossils.

periotic bone The pro-otic, epiotic, and opisthotic bones that surround the ear and which in mammals are fused to form a single periotic bone.

periphyses Short, thread-like filaments that line the opening, or ostiole, of a perithecium in certain types of fungi.

periphyton (aufwuchs) Organisms attached to or clinging to the stems and leaves of plants or other objects projecting above the bottom sediments of freshwater ecosystems.

Periplaneta americana (American cockroach; class Insecta, order Blattodea, family Blattidae) Large, brown roach, 3–4 cm long as an adult, which is a common domestic pest. During the day it generally hides in crevices in man-made environments which offer warmth and food. It is most active at night, and is omnivorous, eating a variety of material, from stored food to human or other animal waste. It will even chew paper and book bindings. More seriously, the insect may harbour diseases that can infect humans. *See also Blatta orientalis*; and *Blattella germanica*.

Periplocaceae Group of plants formerly ranked as a family, and now included as a subfamily (Periplocoideae) of the Asclepiadaceae.

Periplocoideae *See* Periplocaceae.

Periptychidae (superorder Protoungulata, order Condylarthra) Extinct family of primitive ungulates which are known to have lived during the Palaeocene in N. America. The cheek teeth were bunodont and additional cusps were present. *Periptychus* was rather smaller than a modern tapir, and had short legs and a long tail.

perisarc In colonial Coelenterata, the dead, protein-chitinous, cylindrical sheath secreted by the epidermis which surrounds most hydroids.

Perischoechinoida (class Echinoidea) Regular echinoids, without compound plates, in which the perignathic girdle is absent, or of apophyses only; the teeth are grooved; and there are no gill slits or sphaeridia. The number of columns of plates in ambulacra and interambulacra is very variable except in Cidaroida. These echinoids first appeared in the Ordovician.

Perisporiaceae (order Erysiphales) Family of fungi which are obligate plant parasites (dark mildews). Conidia are not formed. There are many genera and species, found chiefly in tropical regions, and occurring mainly on wild plants in forests.

Perissodactyla (cohort Ferungulata, superorder Mesaxonia) Order that comprises those ungulates in which the number of functional toes is reduced to three or one, and a fourth, if present, is reduced, the weight of the animal being borne by the central digit. The order includes the three suborders Ceratomorpha (tapirs, rhinoceroses, and their extinct relatives), Ancylopoda (extinct forms), and Hippomorpha (horse-like forms). They appeared in the Eocene, derived from the condylarths, and reached their zenith in the mid-Tertiary, when they were the most numerous of ungulates. So many fossil remains of them have been found that their evolutionary history is known in greater detail than that of any other mammalian group. Since then the order has declined dramatically, having been displaced by the artiodactyls, and the group as a whole is moving towards extinction.

peristomal Applied strictly to structures associated with the peristome of echinoids, but applied more loosely to structures just outside this region that are associated with feeding habits.

peristome Single or double ring of teeth which fringes the mouth in many types of moss capsule; the peristome can be seen when the lid of a ripe capsule falls or is removed. The teeth are hygroscopic; jerky movements of the teeth on changes in humidity levels aid in the dispersal of the spores.

perithecium Rounded or flask-shaped ascocarp from which ascospores, formed inside the perithecium, are discharged to the exterior via a small pore.

peritoneum *See* mesentery.

Peritrichia (class Ciliatea) Subclass of ciliate protozoa which have a well-developed system of oral cilia. Body cilia are mostly absent, but are present in some immature stages. Cells are variable in shape, and may be sessile or free-swimming. Some are colonial, some have a shell-like lorica. There is one order, with many genera. They are found in freshwater and marine habitats.

Peritrichida (subclass Peritrichia) Order of ciliate protozoa which have the characteristics of the subclass. There are two orders, comprising many genera.

periwinkle *See Vinca*.

perlucidus From the Latin *perlucidus* meaning 'allowing the passage of light', a variety of cloud comprising extensive layers or sheets with holes which allow a view beyond the cloud. The term is applied to stratocumulus and altocumulus. *See also* cloud classification.

permafrost Permanently frozen ground occupying some 26% of the Earth's land surface. Considerable thicknesses may develop, e.g. 600 m on the North Slope of Alaska, and 1400 m in Siberia, but these are partly relict from the last glaciation. It may contain an unfrozen unit, called 'talik', and may be overlain by an active layer.

permanent quadrat Quadrat repeatedly recorded in detail over a number of years in order that plant relationships and changes in them over time may be studied in detail.

permanent wilting percentage (permanent wilting point, wilting coefficient, wilting point) The percentage of water remaining in the soil after a specified test plant has wilted under defined conditions, so that it will not recover unless it is given water.

permanent wilting point *See* permanent wilting percentage.

permeability 1 Property of a membrane or other barrier, being the ease with which a substance will diffuse or pass across it. 2 Capacity of a material to transmit fluids, expressed as hydraulic conductivity. In soils, the ease with which gases, liquids, or plant roots penetrate into or pass through a layer of soil.

permeability coefficient Quantitative estimate of the rate of passage of a solute across a membrane. In a concentration of 10 moles/litre it represents the net number of solute molecules crossing 1 cm^2 of membrane per unit time.

permease One of a class of proteins that act as carrier molecules in cells, facilitating the active or passive transport of various substances across membranes. They have many of the characteristics of enzymes with the exception that they may greatly alter the point of equilibrium of a reaction.

Permian Final period of the Palaeozoic Era, which began 280 million years ago and lasted 55 million years. It is named after the central Russian province of Perm. The period is often noted for the widespread continental conditions that prevailed in the northern hemisphere and for the extensive nature of the southern hemisphere glaciation. Many groups of animals and plants vanished during the Permian, including the rugose corals, trilobites, and blastoid echinoderms.

Pernis (honey buzzards; family Accipitridae) Genus of medium-sized birds of prey which have long, broad wings, and a long tail. They are mainly brown, but can be variable, with a barred tail. Some have crested heads, and all have stiff feathers on the face which protect them from bees and wasps. They inhabit woodland, feed on the larvae of bees and wasps, and nest in trees. There are two or three species, found in Europe, Africa, Asia, and Indonesia.

Perodictus potto (potto) *See* Lorisidae.

Peromyscus leucopus (deer mouse, white-footed deer mouse) *See* Cricetidae.

Peronosporaceae (order Peronosporales) Family of fungi, all of which are obligate plant parasites, causing diseases known as downy mildews. Sporangiophores of the fungus are responsible for the whitish, fluffy patches visible on infected plants. The family contains seven genera.

Peronosporales (class Oomycetes) Order of fungi in which a delicate, coenocytic mycelium is formed. Asexual reproduction occurs by the formation of zoospores or conidia. There are three families. Species are chiefly parasites of vascular plants, but some can live saprotrophically in soil or water. The order includes a number of important plant pathogens.

peroxidase Enzyme that catalyses the oxidation of certain organic compounds using hydrogen peroxide as an electron acceptor.

peroxide Inorganic or organic compound containing linked pairs of oxygen atoms (–O–O–). Peroxides may be regarded as derivatives of hydrogen peroxide (H_2O_2) in which the hydrogen atoms are replaced by other atoms or groups.

peroxisome Round or oval, membrane-bound organelle, 0.3–1.5 μm, found in numbers in most eukaryotic cells. Typically, it has a finely granular, relatively dense internal structure, and contains numerous enzymes associated with the production and degradation of peroxides, in particular the enzyme catalase. *See also* glyoxysome.

peroxyacetyl nitrates *See* PAN; and photochemical smog.

perpresture Unlicensed enclosure or building, especially a new house that has been built within a forest. *Compare* purpresture.

Persea (family Lauraceae) Genus of tropical trees which includes *P. americana* (avocado pear), a widely cultivated fruit tree. There are 150 species.

Persian walnut (*Juglans regia*). *See Juglans*.

persimmon *See Diospyros*.

persistent pulp A pulp cavity of a tooth that remains open throughout life, permitting the continuous growth of the tooth.

Persoonia (family Proteaceae, subfamily Persoonioideae) Genus of small, xerophytic trees and shrubs, which have entire, alternate leaves. The flowers are bisexual, solitary, and axillary, or in short racemes. They are yellow or white. The calyx is often cylindrical. The fruit is a drupe with one seed, a juicy exocarp, and a hard, thick endocarp. There are seven species, endemic to Australia, where they are found throughout the arid regions, often as components of heathlands.

perthophyte Plant-parasitic fungus that kills tissues of its host plant before deriving nutrients from them.

Pertusariaceae (order Lecanorales) Family of lichens in which the thallus is crustose or minutely fruticose. Apothecia are sessile or immersed; they may have open discs or may be closed and perithecium-like. Asci are thick-walled; the spores are large. There are five genera, found on various types of substrate, but rarely on limestone.

pertussis *See* whooping cough.

Peru current (Humboldt current) Oceanic water flowing northwards along the west coast of Chile and Peru, as a consequence of the equator-ward deflection of the westerly oceanic drift as water approaches the continental coastline. This eastern boundary current is slow-moving, broad, and shallow, and is noted for a prominent area of upwelling bringing cold bottom waters to the surface. As the near-surface concentrations of nutrient elements are high there is an abundance of marine life associated with this current.

pesticide General term for natural or synthetic chemical substances that are toxic to pest organisms. Usually the term is applied only to animal poisons as distinct from plant poisons (herbicides).

petai *See Parkia*.

petal In a flower, one of the inner floral leaves, usually brightly coloured, and borne in a tight spiral, or whorled. *See also* corolla.

petaloid Petal-like.

Petalostigma (family Euphorbiaceae, tribe Phyllantheae) Genus of shrubs which have alternate, usually simple or palmate leaves with stipules. The parts of the flower are usually in fives, but often there are many stamens. The fruit is a schizocarp. There are seven species, endemic to Australasia.

Petaluridae (dragonflies; order Odonata, suborder Anisoptera) Archaic family of large odonates in which the eyes are well separated, and the triangles of the fore and hind wings are dissimilar. The nymphs are elongate and hairy, with short, fattened legs; and are found in bogs and swamps, where they burrow in the bottom sediments. There are 10 described extant species, found in the New World, Australasia, Oceania, and the E. Palaearctic.

Petaurista alborufa (red-and-white giant flying squirrel) *See* Sciuridae.

Peterophilia (family Proteaceae) Genus of shrubs which have entire or divided leaves widely spaced along the stem. The flowers are bisexual, held in dense heads or spikes, and usually terminal. The scales are persistent, and the bracts below the inflorescence are often coloured and form an involucre. There are 13 species, all endemic to Australia, where most of them are widely distributed as components of communities on soils of low fertility.

petiole 1 (bot.) *See* leaf. 2 (entom.) *See* gaster; and wasp waist.

Petraeovitex (family Verbenaceae) Genus of slender, woody climbers, some of which are cultivated as ornamentals for their coloured flower bracts. There are seven species, occurring from Malesia to New Zealand.

petrels 1 *See Daption*; *Fulmarus*;. Procellariidae; Procellariiformes; and *Pterodroma*. 2 (diving petrels) *See* Pelecanoididae. 3 (prions) *See Pachyptila*. 4 (storm petrels) *See Oceanites*; and *Oceanodroma*.

Petrobius maritimus *See* Machilidae.

petrocalcic horizon Indurated calcic horizon that is cemented by a high concentration of calcium carbonate, often comprising 40% by weight of the mineral material, and which is impenetrable to plant roots or to spade digging.

petrogenesis All aspects of the evolutionary history of rocks.

petrography Systematic description and interpretation of rock textures and mineralogy in thin-section and as hand-specimens.

petrogypsic horizon Surface or subsurface soil horizon cemented by gypsum so strongly that dry fragments will not slake in water. The cementation restricts penetration by plant roots. This is a diagnostic horizon of the USDA Soil Taxonomy.

petroleum *See* oil.

petrology The general study of rocks in all their aspects.

Petromyidae (rock rat; order Rodentia, suborder Hystricomorpha) Monospecific family of squirrel-like rodents, *Petromys typicus*, which have ribs that can be moved in such a way as to allow the animal to compress its body dorsoventrally. The ears are short; the tail has a terminal tuft; the limbs are short; and the first digit is very short in the hind limbs and vestigial in the forelimbs. The animals shelter in crevices in rocks. They are found only in SW Africa.

Petromys typicus (rock rat) *See* Petromyidae.

Petromyzonidae (lamprey; class Cephalaspidomorphi, superorder Cephalaspidomorpha, order Petromyzoniformes) Small family of fish or fish-like vertebrates, which are without jaws, scales, or paired fins, but which have a funnel-shaped, sucking mouth; a protrusible tongue beset with horny teeth; seven gill openings on each side; and a single nostril between the eyes. Most species are freshwater inhabitants, and the few marine species, e.g. *Petromyzon marinus* (sea lamprey), 80 cm, migrate back to the rivers to spawn. The larvae, called ammocoetes, spend several years burrowed into the bottom of the river before they metamorphose into adult lampreys. There are about 31 species, found on all continents except Africa.

Petromyzoniformes Order of jawless vertebrates including only the family Petromyzonidae.

Petromyzon marinus (sea lamprey) *See* Petromyzonidae.

Petronia (rock sparrows; family Ploceidae) Genus of brown and grey sparrows, which have pale eyestripes, some having yellow throat patches or white tail spots. They inhabit rocky, open country, bush, and forest; feed on seeds and insects; and nest in trees or rock crevices. There are five species, found in Europe, Africa, and Asia.

Pezizales (class Discomycetes) Order of fungi in which the asci have thin walls and open by means of an apical lid or operculum. There are seven families. They are saprotrophic, and found on soil, wood, dung, plant litter, etc.

PGF *See* pressure-gradient force.

pH Value on a scale 0–14 that gives a measure of the acidity or alkalinity of a medium. A neutral

medium has a pH of 7. Acidic media have pH values of less than 7, and alkaline media of more than 7. The lower the pH, the more acidic is the medium; the higher the pH, the more alkaline. The pH value is the reciprocal of the hydrogen ion concentration expressed in moles per litre.

phaccolith In geology, a curved, lensoidal intrusion which is concordant and follows the arches and troughs of folded strata.

Phacidiales (class Discomycetes) Order of fungi in which apothecia develop within a stroma. The stroma ruptures when the hymenium is mature. Typically these fungi are parasitic in plants, the stromata occurring wholly or partly in the tissues of the host.

Phaeophyceae (brown algae) Class of algae which includes no single-celled species; almost all are marine, growing mostly in the intertidal regions. They are the dominant seaweeds in the colder waters of the northern hemisphere. They are typically olive-brown or greenish in colour (at least when wet) due to the presence of the pigment fucoxanthin in the chloroplasts. There are seven orders, and many genera.

Phaethon (tropicbirds) *See* Phaethontidae.

Phaethontidae (tropicbirds; family Pelecaniformes) Family of medium-sized, mainly white sea birds which have some black on the head and wings, and long, white or red central tail feathers. They have stout, yellow or red bills, and pale legs with black, totipalmate feet. They are highly aerial and pelagic; feed mainly on fish caught by diving; and nest on cliffs. There are three species, including *Phaethon*, breeding in the Caribbean, and in the Pacific, S. Atlantic, and Indian Oceans, and ranging some distance in winter.

Phaethornis (hermits; family Trochilidae) Genus of dull, mainly brown and green hummingbirds, which have long, decurved bills, white or buff stripes above and below the eyes, and long tails with elongated white or buff tips. They inhabit rain forest, and nest in a cup-shaped nest placed at the tip of a leaf. There are 22–25 species, found in C. and S. America.

phage *See* bacteriophage.

phagocytosis Process by which a cell membrane can invaginate and enclose externally derived, solid material within a vacuole, without disrupting the continuity of the cell surface. Subsequently this vacuole will fuse with a lysosome and its contents will be wholly or partly digested.

phagotroph *See* consumer organism.

phagotrophy Mode of nutrition in which particulate food is ingested.

Phalacrocoracidae (cormorants, shags; order Pelecaniformes) Family of medium to large, mainly black and brown, aquatic birds, some of which have a greenish or bluish sheen. They have medium-length, slender bills with hooked tips; bare, coloured skin around the eyes; and totipalmate feet. They have short wings, fairly long tails, and fly strongly except for *Nannopterum harrisi* (Galápagos cormorant) which is flightless. They are found on coasts, rivers, and lakes; dive for fish from the surface; and nest on islands, ledges, and trees. There are two or three genera, and 32 species, found worldwide.

Phalacrocorax (cormorants, shags; family Phalacrocoracidae) Genus of 27–31 species, which comprises nearly all of the Phalacrocoracidae.

phalange One of the bones of the digits.

Phalangeridae (koala, possums, cuscus; order Marsupialia, superfamily Phalangeroidea) Family of mainly arboreal, herbivorous marsupials in which the hallux is well developed and often opposable, and the tail is usually long and often prehensile, except for *Phascolarctos cinereus* (koala) in which it is vestigial. Three genera of 'flying phalangers' have extensions of skin between the fore and hind limbs, enabling them to glide. The phalangers are distributed widely throughout Australia and north as far as Celebes. There are about 16 genera, and about 45 species. The koala is often relegated to a family by itself (Phascolarctidae), and nowadays Burramyidae (pygmy possums) and Petauridae (ringtails and gliders) are also generally regarded as families separate from Phalangeridae.

Phalangeroidea (infraclass Metatheria, order Marsupialia) Superfamily comprising the families Macropodidae (kangaroos and wallabies), Phalangeridae (koala, possums, cuscus), and Vombatidae (wombats); others are sometimes recognized in addition. The first pair of lower incisors is diprotodont. In the hind foot the second and third digits are syndactylous; typically the first hind digit is well developed and opposable, but has no claw. The marsupium is well developed. Most Phalangeroidea are herbivores and many show modification for specialized herbivorous diets.

Phallales (class Gasteromycetes) Order of fungi in which the fruit body begins its development underground. It begins as a more or less spherical 'egg' stage, 0.5–5.0 cm in diameter, with a smooth, membranaceous peridium enclosing a gelatinous layer. In some genera the fruit body is mature at this stage. In others a stem-like structure grows from the 'egg' and carries at its tip a cap of spore-bearing tissue; the cap secretes a putrid-smelling slime which attracts flies, and these are responsible for spore dispersal. There are several families, and many genera, found on the ground, on rotting wood, etc.

Phallostethidae (priapum fish; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Family of very small, brackish-water and freshwater fish characterized by the presence of a relatively large, fleshy appendage (the priapum) below the head. The male uses the priapum during mating to secure internal fertilization of the eggs of the female. Almost transparent, *Phenacostethus smithi* (2–3 cm) is found in small schools in the rivers of Thailand. There are possibly four species, found in SE Asia.

phallotoxin Member of a group of poisonous substances present in the fruit bodies of *Amanita*

phalloides and certain other species of *Amanita*. Ingestion of phallotoxins by humans causes vomiting and diarrhoea, and liver damage may occur.

Phallus (order Phallales) Genus of fungi in which the spore-bearing tissue is raised above ground on the tip of a stalk-like structure growing from the underground 'egg' stage. There are about 18 species. *See also* stinkhorn.

phanerophyte One of Raunkiaer's life-form categories, being a plant whose perennating buds or shoot apices are borne on aerial shoots. Such plants are the least protected of those in Raunkiaer's scheme and therefore are most typical of environments where drought, cold, and exposure to strong winds are relatively infrequent. Several subcategories are recognized, the most universal being: (a) evergreen phanerophytes without bud scales (tropical trees) or with bud scales; and (b) deciduous phanerophytes. These groups may be subdivided further according to height, as nano- (less than 2 m), micro- (2–8 m), meso- (8–30 m), and mega- (more than 30 m) phanerophytes. Other subgroups are epiphytic, stem succulent, and herbaceous phanerophytes, the last being confined to humid tropical environments. *Compare* chamaeophyte; cryptophyte; hemicryptophyte; and therophyte.

Phanerozoic Period of geological time comprising the Palaeozoic, Mesozoic, and Cenozoic Eras. It began 570 million years ago at the end of the Precambrian and is marked by the accumulation of sediments containing the remains of animals with mineralized skeletons. The name means the period of 'visible' or 'obvious life'.

Pharaoh's ant *See Monomorium pharaonis*.

pharate The state of an insect that has formed a new cuticle but that is still covered by the old. An insect moults at the end of each instar (stage in its development), the pharate state occurring during the moulting process. There is some argument in the literature as to when each instar ends. Some say it is when the new cuticle is completed, others that it is when the old cuticle has been sloughed.

Pharetronida (class Calcarea, subclass Calcinea) Order of sponges whose body possesses a leucon structure. The skeleton is composed of a calcareous network, or of cemented spicules. They first appeared in the Permian.

Pharomacrus mocino (resplendent quetzal) *See* Trogonidae.

Pharyngobdellida (phylum Annelida, class Hirudinea) Order of annelid worms in which a pharynx is present but jaws are not. All members of the order are carnivorous. Most occur in freshwater habitats, but some are terrestrial. There are five families.

pharynx The part of the gut that lies between the buccal cavity and the oesophagus. In primitive vertebrates (e.g. *Amphioxus*) it occupies almost half the length of the alimentary canal. Probably its original function was connected with the sifting of particles of food, but in lower vertebrates it is concerned with respiration and gill slits or lungs open into it.

Phascolomyidae *See* Vombatidae.

phase 1 Little-used term in biostratigraphy, related to time. According to early geologists it was the time-equivalent of a zone. 2 In chemistry and in other fields of geology frequent reference is made to the 'phases' of liquids and to a 'phase boundary' (the line marking the contact between two constituent or liquid phases).

phase diagram Graphical method for examining stability in biological systems, e.g. host–parasite relationships. The system variables (the numbers of host and parasite organisms) at different times are plotted against one another, and change over time is shown by a line connecting the co-ordinate points for successive time values. The form of the resulting curve indicates the stability of the system. A line spiralling inward indicates damped oscillations favouring ultimate stability; an outward spiral suggests ultimate instability. By testing different values for the number of organisms it is possible to establish limits for stability. The technique has considerable practical relevance in agriculture.

Phasianidae (pheasants, partridges, quails; order Galliformes) Family of small to large gamebirds which have black and brown cryptic or highly multicoloured plumage. Many have crests, and bare skin and wattles on their faces. Their bills are short and stout; their necks short to long; their tails short to very long; and their legs short to long, often having one or more spurs. The tails of peacocks are highly elaborate for display. They are terrestrial: they inhabit woodland, grassland, and open, barren areas; feed on seeds, berries, and insects; and nest on the ground. There are 48–50 genera, and 190 species, some migratory, found worldwide. Many are bred as gamebirds.

Phasianus (pheasants; family Phasianidae) Genus of large gamebirds, the males of which have metallic green heads with red wattles around the eyes; two ear tufts; and coppery-red or green body plumage, with a very long, black-barred, brown tail. Females are dull brown. Pheasants inhabit open country and cultivated land, feed on seeds and berries, and nest on the ground. *P. colchicus* (common or ring-necked pheasant) has been introduced to Europe, N. America, and New Zealand. There are two species, occurring naturally in Asia.

Phasianus colchicus (common pheasant, ring-necked pheasant) *See Phasianus*.

Phasmatidae (stick insects, walking sticks; class Insecta, order Phasmatodea) Family of large to very large insects, whose common name refers to their resemblance to twigs: this resemblance is often striking and is enhanced by their habit of swaying slowly from side to side. When disturbed, stick insects may become cataleptic and fall to the ground, or else rustle and expand brightly coloured hindwings. They may also produce repugnant odours and secretions. Almost all of the 2000 or so species are found in warmer regions of the world, although two species from New Zealand have established themselves in the Scilly Isles (Great

Britain). One species, *Carausius morosus*, is a widely studied laboratory animal.

Phasmatodea (Phasmida; class Insecta) Order of large to very large, terrestrial insects, which includes the stick insects (walking sticks) and leaf insects (walking leaves). They are exopterygote, and differ from the Orthoptera in that the wing buds do not reverse their orientation in later instars. Some species are wingless, and in most species the female has reduced wings and cannot fly. Unlike the Orthoptera, phasmids do not have saltatorial hind legs. Nor do they have auditory organs, or lateral flanges on the pronotum. Eggs are laid by being flicked from the tip of the abdomen, and are free and seed-like, having thick, often intricately sculptured shells. Parthenogenesis is widespread among the order. All species are foliage-feeders, and a few are of economic importance as forest defoliators. There are more than 2500 species, almost all of which are tropical or subtropical.

phasmid 1 In Nematoda, one of a pair of sensory glands opening to either side of the tail and probably functioning as a chemoreceptor. 2 *See* Phasmatodea.

Phasmida *See* Phasmatodea.

pheasants *See* Phasianidae; and *Phasianus*.

Phebalium (family Rutaceae) Genus of small, xerophytic trees and shrubs, which have simple, usually alternate leaves, without stipules. The flowers are bisexual with a united corolla, and with twice as many stamens as corolla-lobes. The seeds contain copious endosperm. There are 40 species, only one of which is found outside Australia, and then only in New Zealand.

Phellinus (family Hymenochaetaceae, order Aphyllophorales) Genus of fungi in which the fruit bodies are typically bracket-like or hoof-shaped, hard and leathery or woody in texture, with rust-brown convex cap and a layer of tubes on the under-side. The spores are smooth. They are found on wood; some species are parasitic on trees.

phelloderm *See* bark.

Phenacodontidae (superorder Protoungulata, order Condylarthra) Extinct family, comprising the best known of the condylarths, which was distributed throughout the Holarctic region from the Palaeocene to the Eocene. Early forms were small and had claws but later forms were larger and possessed more ungulate characteristics. *Phenacodus*, an Eocene form, was about 1.2 m long, and possessed hoofs on the ends of the phalanges of all five digits, of which the third was the longest. The dentition was complete: the canines large and the diastema small, but the molars square and bunodont. In other respects *Phenacodus* was relatively unspecialized. The tail was long, and the spine curved. The skull was low and long, and the braincase small.

Phenakospermum (family Strelitziaceae) Genus of unbranched trees whose banana-like leaves are held in a plane, like a huge fan. The fruit is a capsule with brightly coloured seeds. There are two species found in the north of tropical S. America.

phenetic classification The grouping of biological organisms on the basis of observed physical similarities. *See* phylogenetic systematics.

phenocryst In igneous petrology, the larger and often well-formed crystals set in a finer groundmass or matrix. Rocks containing phenocrysts are said to be porphyritic.

phenol Aromatic compound bearing one or more hydroxyl groups.

phenology The study of the impact of climate on the seasonal occurrence of flora and fauna (dates of flowering, migration, etc.), and of the periodically changing form of an organism, especially as this affects its relationship with its environment (e.g. the development of a tree seedling into a sapling and later a mature tree).

phenotype The observable manifestation of a specific genotype; those properties of an organism produced by the genotype in conjunction with the environment that are observable. Organisms with the same overall genotype may have different phenotypes because of the effects of the environment and of gene interaction. Conversely, organisms may have the same phenotype but different genotypes, as a result of incomplete dominance, penetrance, or expressivity.

phenotypic adaptation *See* adaptation.

phenotypic variance The total variance observed in a character.

phenylalanine Aromatic, non-polar amino acid.

pheromone Chemical substance, produced and released into the environment by an animal, which then elicits a physiological and/or behavioural response in another individual of the same species. For example, pheromones are released by a variety of glands on the abdomen, head, and wings of insects.

Pheucticus (grosbeak; family Cardinalidae) Genus of stocky, large-billed, yellow and black, orange and black, or red, white, and black finches. They inhabit forest edges, scrub, and cultivated land; feed on seeds, fruit, and insects; and nest in trees and bushes. There are six species, some migratory, found in N., C., and S. America. *P. ludovicianus* (rose-breasted grosbeak) occurs in Britain as a vagrant.

Pheucticus ludovicianus (rose-breasted grosbeak) *See Pheucticus*.

phialid (phialide) Bottle-shaped structure within which or from which conidia develop. It is formed by imperfect stages of some fungi.

phialide *See* phialid.

Philadelphus (mock orange, 'syringa'; family Saxifragaceae) Genus of shrubs, formerly placed in the family Hydrangeaceae, with opposite leaves, and attractive tetra-, penta-, or hexamerous flowers with white petals, many stamens, and a four-celled ovary. The name 'syringa' is often incorrectly used for this genus; *Syringa* is actually the scientific name for lilac. There are 50 species in the northern temperate zone, especially E. Asia and N. America;

the genus is much cultivated for the fragrant flowers which superficially resemble orange blossom.

Philanthis *See* Sphecidae.

Philemon (friarbird; family Meliphagidae) Genus of medium-sized, brown birds which have pale under-parts. Their heads have areas of bare, black skin, with a black knob on the forehead. The bill is sharp and decurved. They inhabit forest and scrub, feed on nectar and insects, and nest in trees. There are 17 species, found in Australia, New Guinea, and Indonesia.

Philepitta (asities) *See* Philepittidae.

Philepittidae (asities, false sunbirds; order Passeriformes) Family which comprises two distinct genera, *Philepitta* (asities) and *Neodrepanis* (false sunbirds). Asities are small, plump, short-tailed birds with a yellow-green or black body and black head, and a bare wattle around the eyes. The bill is fairly short and slightly decurved. Asities feed on fruit and build a nest suspended from a branch. False sunbirds are small, blue and yellow, with a bare wattle around the eyes, and a long, slender, decurved bill. They feed on nectar and insects. Both genera inhabit forest bushes. There are two species in each genus, confined to Madagascar.

Philesiaceae Family of monocotyledonous shrubs, climbers, and epiphytes, closely allied to the Amaryllidaceae, which have alternate, simple leaves without stipules. The flowers are regular, bisexual, large, and pendulous; they are axillary or held terminally, and are usually solitary. There are three sepals and three petals, the sepals and petals often resembling one another. There are three stamens, with large anthers. The ovary is superior, with three, fused carpels: it is either uni- or tri-locular, with a simple, three-lobed style. The fruit is a berry. There are eight genera and 10 species, all of them confined to the southern hemisphere.

Philippia (family Ericaceae) Genus of tree heaths, comprising 80 species which occur in tropical and southern Africa, the Mascarenes, and Madagascar.

Philippine creepers *See* Rhabdornithidae.

Philodendron (family Araceae) Genus of herbs, mainly climbing, in which the leaf nervation is pinnate and reticulate, the blade sometimes being divided. Many are ornamentals. There are 275 species, occurring in tropical America.

Philomachus (ruff; family Scolopacidae) A monotypic genus, *P. pugnax* is a brown, medium-sized, wading bird. The male is larger than the female and has a large, neck ruff, variable in colour, and ear tufts in its breeding plumage. Males display in a group or 'lek'. They breed in wetland meadows and inhabit fields and marshes in winter. They feed on invertebrates and nest on the ground. They breed in Europe and Asia, migrating to Africa and S. Asia in winter.

philopatry The tendency of an individual to return to or stay in its home area. Most animal species show some degree of philopatry, and one sex may show it to a greater degree than the other, e.g. male birds and female mammals tend to be more philopatric than those of the opposite sex. *Compare* dispersal.

Philopteridae (order Phthiraptera, suborder Ischnocera) Family of chewing lice which are parasitic on birds of many orders. This family is the largest in the Ischnocera, and its members differ from those of the others in not having an entire front margin to the head, and in having two tarsal claws to each leg. All species are believed to feed on fragments of feather and dead skin. As with other Ischnocera, many male Philopteridae use their antennae to clasp the female during copulation, and in one genus, *Harrisoniella*, the male antennae are much larger than the front legs, which have taken on a sensory function. There are 100 genera, and 1500 species.

Philydraceae Family of monocotyledonous, erect, rhizomatous herbs, which have two-ranked, sheathing, linear leaves, clustered or in a basal rosette. The flowers are solitary, irregular, and bisexual, with a single stamen. The ovary is superior, with three, fused carpels forming a single locule with numerous ovules. The style is simple. The fruit is a capsule, with many seeds, which contain endosperm. Several species are components of lagoon and sedge communities, sometimes in fairly deep water. There are four genera, and five species, restricted in their distribution to SE Asia and Australia.

phlebotomus fever *See* sandfly fever.

phloem Tissue comprising various types of cells, which transports dissolved organic and inorganic materials over long distances within vascular plants, by mechanisms which are still not understood fully. It can be distinguished from xylem by the general absence of thickened cells and by the presence of cells containing areas resembling a sieve.

phlogistic Capable of causing inflammation.

Phlox *See* Polemoniaceae.

phobotaxis Random change in direction of locomotion in a motile micro-organism or cell made in response to a given stimulus.

Phocidae (seals; order Carnivora, suborder Pinnipedia) Family of marine carnivores in which there is no external ear, the tail is small, and the hind limbs cannot be turned forward to assist movement on land. Most feed on fish and marine invertebrates, but some feed on macroplankton, and one species feeds on penguins. Despite superficial similarities, the phocid and otariid seals are believed to have evolved independently and not to be closely related to one another. The phocid seals diverged from the otter branch of the Mustelidae and can be traced back to the Miocene. They are more completely adapted for aquatic life than the Otariidae. Phocid seals are found in all oceans, mainly in high latitudes, and in the Caspian Sea and Lake Baikal. There are two genera, and nine species.

Phocoena phocoena (porpoise) *See* Phocoenidae.

Phocoenidae (order Cetacea, suborder Odontoceti, superfamily Delphinoidea) Family of marine mammals which lack a distinct beak, the head being

either rounded or conical. The dorsal fin is low or absent, the tail-fin is narrow with a shallow notch, and the flippers are short. Typically the teeth are compressed laterally and range in number from 30 to 60 in each jaw. Phocoenidae feed mainly on fish, but also on marine invertebrates. They are found throughout the northern hemisphere and in temperate regions of the southern hemisphere. There are about seven species, in three genera: *Phocoena* (*P. phocoena* is the common porpoise, distributed widely in the northern hemisphere), *Neophocoena*, and *Phocoenoides*.

Phodilus (bay owls) *See* Tytonidae.

phoebes *See Sayornis*.

Phoenicopteridae (flamingos; order Ciconiiformes) Family of large, white, pink, and vermilion birds which have black wing tips. They have very long necks and legs; short, webbed feet; bare faces; and a deep bill, bent down at the mid-point. The mandibles have lamellae for sieving plankton. Flamingos inhabit shallow, freshwater and salt lakes, feed on plankton and small invertebrates, and nest colonially on mud platforms. There are three genera, some migratory, and five or six species, found in S. Europe, Africa, S. Asia, C. and S. America, and the W. Indies. *See also* primary.

Phoenicopterus (flamingos; family Phoenicopteridae) Genus of typical flamingos which have rosy-pink plumage, black primaries, pink or blue legs, and a pink or yellow bill with a black tip. There are two or three species, sometimes regarded as a single species, found in S. Europe, S. Asia, C. and S. America, and the W. Indies.

Phoeniculidae (wood-hoopoes, scimitarbills; order Coraciiformes) Family of medium-sized, slender, black birds, which have a green or purple gloss to their plumage. Their bills are long, slender, and decurved, usually red or black; and they have long, gradated tails, in some species tipped white. *Phoeniculus* species (wood-hoopoes) are more gregarious and noisy than *Rhinopomastus* (scimitarbills). They are arboreal: they are found in most African forests and woods; feed on insects, fruit, and seeds; and nest in tree holes. The two genera contain eight species, found in Africa. They are sometimes included in the Upupidae.

Phoeniculus (wood-hoopoes) *See* Phoeniculidae.

Phoenicurus (redstarts; family Turdidae) Genus of small, brightly coloured birds which have orange bellies, black throats, and black, blue, or grey heads and backs. Females are duller brown. Both sexes have distinctive orange-red tails and rumps. They inhabit woodland and open, rocky areas; feed on insects; and nest in trees and crevices, sometimes in buildings. There are 11–13 species, many migratory, found in Europe, Africa, and Asia.

Phoenix (family Palmae) Genus of palms in which the leaves are pinnate (with a terminal leaf present, a feature unique among the palms), basal leaflets often occurring as spines. They are dioecious. The inflorescences form among the leaves, as one big, caducous spathe. The flowers are single, with three carpels. The fruits are fleshy, the seed hard and grooved. Several are widely cultivated. *P. dactylifera* is the date palm. There are 17 species, found from the Canary Islands and Africa to Sumatra and Malaya, mostly in seasonal or dry climates.

Pholadina (class Pelecypoda, order Myoida) Suborder of thin-shelled, unequilateral pelecypods, which differ from other members of the order in possessing one or more additional plates. The foot is circular and acts as a suction disc. A small internal ligament and chondrophore are present. There are no hinge teeth. Musculature is isomyarian. The gills are elongate, with a pair of demibranchs in most forms. Pholadina live in holes they bore, commonly on a rock, coral, or wood substrate. They first appear in rocks of Jurassic age.

Pholadomyoida (class Pelecypoda, subclass Anomalodesmata) The only order belonging to the subclass, whose characteristics are therefore those of the subclass. *See* Anomalodesmata.

Pholidae *See* Pholididae.

Pholididae (Pholidae; butterfish, gunnel; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of slender, compressed, marine fish, in which the body has very small scales, and the skin is often slimy ('buttery'). The long, low, dorsal fin begins behind the head and terminates close to the small tail. Although the anal fin is long-based, the pelvic fins are minute. Commonly distributed along the shores of the cooler parts of the northern hemisphere, the fish tend to hide in crevices. Often showing a row of about 10 dark spots along its back, *Pholis gunnellus* (butterfish), 20 cm, frequents the kelp zone, feeding on small animals. There are about 13 species.

Pholidota (infraclass Eutheria, cohort Unguiculata) Order comprising the single family Manidae, the pangolins or scaly ant-eaters.

Pholiota (family Strophariaceae) Genus of fungi which form mushroom-shaped fruit bodies. The gills are initially pale but later become brown; the stipe is central and may or may not bear a ring. The spore print is brown to rusty-brown. They are found on wood or on the ground, often in clusters.

Pholis gunnellus (butterfish) *See* Pholididae.

Phoma (order Sphaeropsidales) Form-genus of fungi in which conidia are produced in dark-coloured, flask-shaped pycnidia. The genus includes many important, seed-borne, plant pathogens, which cause for example various types of stem and root rots.

Phoneutria fera (suborder Araneomorphae, family Ctenidae) The most poisonous species of spider in the world, from which a single bite containing 8 mg of venom is enough to kill 300 mice.

phoresy Method of dispersal in which an animal clings to the body of a much larger animal of another species and is carried some distance before releasing its grip and falling. *See* Pseudoscorpiones.

Phoridae (scuttle flies; class Insecta, order Diptera, suborder Cyclorrapha) Family of small or minute,

grey-black or yellowish flies which run actively and have a curious, humped appearance. The antennae seem to comprise one large segment, but this conceals the other segments. The large segment bears a long apical or subdorsal arista. Wings are often vestigial or absent. If they are present, the anterior veins are very heavily developed. Sc is free at the base, and the remaining veins are weak, and atypically placed. Larvae live in decaying or putrefying material. Several abnormal species exist, with the possibility of some hermaphrodite adults. More than 3000 species are known to exist. *See also* venation.

Phormidium (order Nostocales) Genus of filamentous, sheathed cyanobacteria in which the sheaths tend to coalesce. They are capable of gliding motility. They are found in all types of aquatic environment, and on wet rocks, damp soil, etc., often forming dense mats. They are frequently difficult to distinguish from *Lyngbya* and *Plectonema* (the LPP group).

Phormium (family Agavaceae) Genus of plants which are rosettes with a woody rootstock. There are two species, occurring in Norfolk Island and New Zealand. *P. tenax* is New Zealand flax.

Phoronida 'Horseshoe worms', which are so called because of their horseshoe-shaped feeding organ. They are sessile suspension-feeders, most living in burrows. It is widely believed that they are ancestral to the brachiopods and bryozoans, although they first appear in rocks of Devonian age, i.e. after the other two phyla.

phosphatase Enzyme that catalyses reactions involving the hydrolysis of esters of phosphoric acid.

phosphate Rock or deposit made up largely of inorganic phosphate, commonly calcium phosphate.

phosphatide One of a large group of naturally occurring phospholipids that are derivatives of glycerol phosphate and which normally contain a nitrogenous base.

phosphatidyl choline *See* lecithin.

phosphodiester bond Bond between two molecules formed by phosphoric acid, which is esterified once to each molecule.

phospholipid Polar lipid comprising a lipid derivative of glycerol that contains one or more phosphate groups. Phospholipids are particularly important with regard to the structure and functioning of biological membranes.

phosphorus (P) Element, required by plants in the oxidized form, as orthophosphate (PO_4^{2+}). The special chemical properties of this compound are utilized in reactions in which energy is transferred, often involving ATP. It is also a good buffer helping maintain a neutral pH. The leaves of phosphate-deficient plants become dark green or blue-green and a reddish pigment may develop. Growth is generally reduced.

phosphorylation The addition of a phosphate group to a compound, involving the formation of an ester bond between the reactants.

phosphotransferase Enzyme that catalyses reactions involving the transfer of a phosphate group from one substrate to another.

photic zone Zone of water within which organisms are exposed to sunlight. It is divided at the compensation level, with the euphotic zone above and dysphotic zone below.

photo-autotroph Phototrophic organism that uses carbon dioxide as its main or sole source of carbon.

Photobacterium (family Vibrionaceae) Genus of Gram-negative bacteria in which the cells are ovoid to rod-shaped, and typically motile. They are chemo-organotrophic, and can grow in the presence or absence of air. Under appropriate conditions these bacteria can emit light. They are found in marine environments and in the luminous organs of certain fish and cephalopods.

photochemical reaction Chemical change induced by light. Such a reaction can be distinguished from other chemical reactions by being largely independent of temperature. An example is photosynthesis, in which light causes electron shifts in the photoreceptors.

photochemical smog Hazy condition of the atmosphere due to the reaction of hydrocarbons with molecules of nitrogen oxide in sunlight which produces complex organic molecules of peroxyacyl nitrates (PAN). In humid conditions these molecules produce smog. Such phenomena are common in large urban areas (e.g. the Los Angeles basin and Athens) where there are stable atmospheric conditions and a high level of hydrocarbon input from incomplete combustion in car engines. Natural photochemical reactions occur in the high atmosphere with the absorption of radiation by oxygen to produce ozone. *See also* ozone layer; and smog.

photodissociation The splitting of a molecule into atoms or other molecules as a result of its absorption of radiation.

photoheterotroph Phototrophic organism that uses organic compounds as its main or sole source of carbon.

photo-inhibition The slowing or stopping of a plant process by light, e.g in the germination of some seeds.

photo-ionization The absorption of solar energy in the upper atmosphere (mesosphere and thermosphere) by oxygen (O and O_2) and nitrogen oxide (NO) molecules, accompanied by the release of electrons. The removal of the negatively-charged electrons leaves atoms or molecules as positively-charged ions. Ionic concentration varies throughout the ionosphere. *See also* aurora.

photokinesis Change in the speed of locomotion in a motile organism or cell made in response to a change in light intensity.

photolithotroph Phototrophic organism in which photosynthesis is associated with the oxidation of an inorganic compound (or element, in the case of some photosynthetic bacteria). For example, green plants obtain energy from sunlight by photosynthesis, during which water is oxidized to yield oxygen.

photomorphogenesis The effect of light in regulating plant form and growth.

photonasty Nastic response of a plant organ to the stimulus of light.

photo-organotroph A phototrophic organism in which photosynthesis is associated with the oxidation of organic compounds. Certain photosynthetic bacteria are photo-organotrophic.

photoperiodism The response of an organism to periodic, often rhythmic, changes either in the intensity of light or, more usually, to the relative length of day.

photophore Luminous organ, modified from a mucous gland, found in the skin of fish. Rows of photophores are present in many deep-sea fish, which apparently can produce flashes of blue-green to orange light at will. The photophores secrete a compound which glows when activated, or contain colonies of phosphorescent bacteria.

photophosphorylation The formation of ATP, as in photosynthesis, by processes which require light.

photoreceptor Pigment that absorbs the light that may be used in various plant processes. Examples include phytochrome and the photosynthetic pigments.

photorespiration A light-activated type of respiration that occurs in the chloroplasts of many plants. It differs biochemically from normal (dark) respiration in that it involves glycolate metabolism. It is a process that is wasteful of both carbon dioxide and energy, and those plants in which it occurs have high carbon-dioxide compensation points. It occurs only at very low rates in C4 plants which consequently have lower compensation points and greater photosynthetic efficiency. Its biological function is not clearly understood.

photosynthesis Term given to the series of metabolic reactions that occur in certain autotrophic organisms, whereby organic compounds are synthesized by the reduction of carbon dioxide using energy absorbed by chlorophyll from sunlight. In green plants, where water acts both as a hydrogen donor and as a source of released oxygen, photosynthesis may be summarized by the empirical equation:

$$CO_2 + 2H_2O \xrightarrow[\text{light}]{\text{chlorophyll}} [CH_2O] + H_2O + O_2 \uparrow$$

(oxygen being released as a gas). Photosynthetic bacteria are unable to utilize water and therefore do not produce oxygen. Instead they may use hydrogen sulphide (purple and green sulphur bacteria) or organic compounds (purple non-sulphur bacteria) as a source of hydrogen.

photosynthetic quotient The volume of oxygen released in photosynthesis as a proportion of the volume of carbon dioxide used in that process.

photosystem I The system of photosynthetic reactions involving the pigment P_{700} that requires light of longer wavelength: it results in the reduction of $NADP^+$ and the production of ATP through photophosphorylation.

photosystem II The system of photosynthetic reactions involving chlorophyll *a*, chlorophyll *b*, and accessory pigments that requires light of shorter wavelength: it results in the dissociation of water and the evolution of molecular oxygen.

phototaxis Change in direction of locomotion in a motile organism or cell made in response to a change in light intensity.

phototroph Organism that obtains its energy from sunlight. In the great majority of phototrophs the process by which light energy is harnessed is called 'photosynthesis'.

phototropism (heliotropism) Tropic response of a plant or plant organ to the stimulus of light.

Phragmites (reed grasses; family Gramineae, subfamily Arundinoideae, tribe Arundineae) Genus of grasses which have robust stems, and large plumes of slender spikelets forming a nodding panicle. They are perennial with rhizomes. They are tall and stout. The ligule is a ring of hairs. All the florets have a tuft of long, silky hairs arising from the base. The lemma is three-nerved, and twice as long as the upper glume; and the palea is less than one-third the length of the lemma. There are usually three stamens, although often there are fewer in the lower florets. The ovary is glabrous, with a short style. There are three species, found throughout the world, usually in swampy or marshy conditions.

Phragmites cliffwoodensis Early representative of the reed grasses, recorded from the mid-Cretaceous of New Jersey, USA. It has rather uncertain affinities but if accepted would be the first of the family Gramineae.

Phragmobasidiomycetidae (class Hymenomycetes) Subclass of fungi in which the basidia are divided by septa. The fruit bodies are typically gelatinous or waxy. There are three orders, including saprotrophs, parasites, and symbionts. *See also* jelly fungus.

phragmosis *See* soldier.

phreatic zone (zone of saturation) The soil or rock zone below the level of the water table, where all voids are saturated and where the rate of weathering is reduced. *See also* vadose.

Phrynomeridae (class Amphibia, order Anura (Salientia), suborder Diplasiocoela) Small family of frogs, which have finger pads and elongate fingers as do tree frogs. The pectoral girdle is vestigial. Phrynomeridae are seldom arboreal. Usually they climb and burrow in rock crevices or termite mounds. There are six species, occurring in southern Africa.

Phrynophiurida (brittle-stars; class Stelleroidea, subclass Ophiuroidea) Order of brittle-stars, in which the articulation between the radial shields (large, radially positioned, paired, aboral plates) and genital plates consists of a facet or ridge. The disc and arms are entirely covered by skin.

Phthiraptera (lice; class Insecta) Order of insects which are closely related to Psocoptera, Hemiptera, and Thysanoptera. Lice may be distinguished by

the lack of wings and ocelli; the reduction of the antennae to three flagellomeres, scape, and pedicel; the loss of the metathoracic spiracles; and the reduction of the ovipositor. All species are obligate ectoparasites of birds and mammals, feeding on skin debris, feathers, sebaceous exudates, or blood. The eggs are attached to the fur or feathers of the host, and there are three nymphal stages. There is no pupa, and the whole of the life cycle is spent on the body of the host. The order comprises about 3000 described species, in four suborders: Anoplura, Rhyncophthirina, Ischnocera, and Amblycera.

phthisis (adj. phthitic) Old name for pulmonary tuberculosis (consumption).

phycobilin Generic term for a group of substituted open-chain tetrapyrolles that occur in conjugation with specific proteins. The resulting complex functions as an accessory pigment in the chloroplasts of numerous algal species.

phycobiont The principal algal or cyanobacterial (blue-green algal) symbiont in a lichen.

phycocyanin Blue accessory pigment, consisting of a protein conjugated with a phycobilin. It is found in the chloroplasts of many algal species.

Phycodurus eques (leafy sea dragon) *See* Syngnathidae.

phycoerythrin Red accessory pigment, consisting of a protein conjugated to a phycobilin. It is found in the chloroplasts of many algal species.

phycology (algology) The study of algae.

phycomycetes *See* lower fungi.

phycovirus Virus that infects and replicates in algae.

Phylactolaemata (phylum Bryozoa, subphylum Ectoprocta) Class of non-mineralized, freshwater ectoprocts in which the lophophore is U-shaped. The mouth is covered by a lip. The class has a probable Upper Cretaceous representative, but otherwise is known only from the Recent.

phyletic evolution Evolutionary change within a lineage, as a result of gradual adjustment to environmental stimuli.

phyletic gradualism Theory holding that macroevolution is merely the operation of micro-evolution over relatively long periods of time. Thus gradual changes eventually will accumulate to the point at which descendants of an ancestral population diverge into separate species, genera, or higher-level taxa.

Phyllanthus (family Euphorbiaceae) Genus of herbs, shrubs, or mostly small trees, in which the leaves are often in two ranks, and the shoots resemble pinnate leaves. The flowers are minute, and held in dense clusters. The fruit is dry and dehiscent, or fleshy and indehiscent. Some species have green phylloclades bearing flowers on their margins. There are 600 species, with a pantropical distribution.

Phylliidae (leaf insects, walking leaves; class Insecta, order Phasmatodea) Family of large insects in which the body is flattened dorsoventrally, and the legs have broad, flattened extensions, thus giving the insect a strikingly leaf-like appearance. The family is found mainly in SE Asia and New Guinea, although, together with the stick insects (Phasmatidae), these insects (e.g. *Phyllium bioculata*) have become popular household pets in other parts of the world. There are more than 50 species.

phyllite Fine-grained rock with a well-developed schistosity, which often has a silky sheen due to the abundance of fine, white micaceous material.

Phyllium bioculata *See* Phylliidae.

phyllocladium One of many small, scale-like projections that occur on the pseudopodetium in lichens of the family Stereocaulaceae.

Phyllocladus (family Podocarpaceae) Genus of southern hemisphere conifers, whose foliage of phylloclades is borne in the axils of scale leaves. The seed is arillate. The genus yields useful timber. There are seven species, occurring from Borneo to New Zealand (where they are known as 'celery pines').

phyllody Symptom in certain plant diseases: parts of a flower are replaced by leaf-like structures.

Phylloglossum (family Lycopodiaceae) Monotypic genus of plants, with two underground tubers, a basal tuft of cylindrical pointed leaves, and a leafless stem bearing a single terminal cone. It is confined to Australasia.

Phylloscopus (leaf warblers; family Sylviidae) Genus of small, active warblers which have green or brown upper-parts and pale under-parts. They have well-defined supercilia, and many have pale central crown stripes, wing bars, and rumps. They inhabit woodland and forest, feed on insects, and nest in trees, bushes, and on the ground. There are 41 species, most highly migratory, found in Europe, Africa, Asia, Indonesia, and New Guinea.

Phyllostomatidae (New World leaf-nosed bats; order Chiroptera, suborder Microchiroptera) Family of bats in most of which the nose leaf is simple and shaped like a spearhead, point uppermost, the nostrils being visible through it. The ears are mobile and well separated. Most are insectivorous, but some feed on vertebrates; others are omnivorous, or feed on fruit or nectar. They are distributed widely from the southern USA to N. Argentina, and in the W. Indies. There are 48 genera, and more than 120 species.

phyllotaxis In a plant, the arrangement of leaves on the stem—as opposite pairs, whorls, alternate, spirals, etc.

Phylloxeridae (order Hemiptera, suborder Homoptera) Small family of homopterans, related to Aphididae. Many species feed on *Quercus* species (oaks), but the best known is the vine phylloxera, which almost destroyed the European vine industry in the late nineteenth century. It was defeated by grafting European vines on to stocks of an American species whose roots were not affected by a subterranean stage in the insect's life cycle.

phylogenetic systematics The study of biological organisms, and their grouping for purposes of classification, based on their evolutionary descent. *See also* cladistics.

phylogeny Evolutionary relationships within and between taxonomic levels, particularly the patterns of lines of descent, often branching, from one organism to another—the relationships of groups of organisms as reflected by their evolutionary history.

phylogerontism (racial senescence) Outmoded view of evolution which asserted that lineages proceeded through a life cycle, from youth to senility. Lineages on the verge of extinction were thus thought of as examples of 'racial senescence' or 'phylogerontism'.

phylum In animal taxonomy, one of the major groupings, coming below subkingdom and kingdom, and comprising superclasses, classes, and all lower taxa. Sometimes, confusingly, the term is used to mean 'lineage': the root of 'phyletic', 'phylogeny', etc.

Phymosomatoida (superorder Echinacea) Order of regular echinoids, which are similar to the Hemicidaroida, but have an imperforate primary tubercle. They first appeared in the Lower Jurassic.

Phrynosoma (horned lizards; order Squamata, suborder Sauria (Lacertilia), family Iguanidae) Genus of lizards, which have flat, squat bodies, covered with spiny tubercles, and short tails. If disturbed, they may squirt blood from the corners of the eyes. They can burrow backwards into the sand. They feed on insects. They occur in the deserts of Mexico and the SW USA.

Physalia physalis (Portuguese man-of-war) *See* Nomeidae; and Rhizophysaliina.

Physarales (subclass Myxogastromycetidae) Order of slime moulds, in which the spores in masses appear deep purple-brown or black. The order contains more than half of all the known myxomycetes.

Physarum (order Physarales) Large genus of slime moulds, including *P. polycephalum*, which can be cultivated and induced to fruit under laboratory conditions. It forms a conspicuous yellow plasmodium which gives rise to clusters of stalked yellowish or grey sporangia. *P. polycephalum* is found on dead wood and on fleshy fungi. It is distributed widely in the USA and has been reported from other countries, including France and Japan. The genus comprises about 85 species.

Physciaceae (order Lecanorales) Family of lichens in which the thallus may be crustose, foliose, or fruticose, and may be grey, yellow, or yellowish-green. Spores are typically aseptate or with 1–3 septa, becoming brown. There are many genera, found typically on substrates rich in nitrogenous matter (e.g. bird droppings).

Physeter catodon (sperm whale) *See* Physeteroidae.

Physeteridae (sperm whales; order Cetacea, suborder Odontoceti, superfamily Physeteroidea) Family of whales in which the head is blunt and more or less rectangular in shape, containing a reservoir filled with spermaceti. Functional teeth are present only in the lower jaw. They feed on squid, fish, and crustacea, diving deeply to do so. They are distributed throughout all oceans. There are two genera, and three species, *Physeter catodon* (sperm whale), and *Kogia breviceps* and *K. simus* (pygmy sperm whales).

Physeteroidea (order Cetacea, suborder Odontoceti) Superfamily comprising the families Ziphiidae (beaked and bottle-nosed whales) and Physeteridae (sperm whales), mammals capable of diving to great depths—2000 m in the case of sperm whales. The head contains a reservoir filled with spermaceti, vascular connective tissue rich in oil. It has been suggested that the spermaceti permits heat loss from the body and so increases the density of the oil, providing neutral buoyancy at the depths to which the animals penetrate.

physical factor Factor in the abiotic environment that influences the growth and development of organisms or biological communities.

physiognomy The form and structure of natural communities. *Compare* morphology.

physiological ecology The study of the functioning of organisms in relation to their environments.

physoclistous Applied to the condition in bony fish in which there is no connection or duct between the swim-bladder and the intestinal tract. In physoclists, the gas pressure of the swim-bladder is regulated by special tissues or glands. This condition is found among the 'higher' bony fish, e.g. the perch-like fish.

Physocomitrium pyriforme *See* pear moss.

physogastry Extreme distension of the abdomen in female termite reproductives, caused by the growth of the ovaries, gut, and fat body.

Physophorina (order Siphonophora) Suborder of Cnidaria whose members have an apical float which lacks a pore and is attached to a stem bearing modified zooids divided into two distinct regions.

physostomous Applied to the condition in bony fish in which the swim-bladder is connected to the intestinal tract by a special duct (*ductus pneumaticus*). In physostome fish, the gas pressure can be regulated by swallowing air or by releasing it via the gut. This condition is found among the somewhat more primitive bony fish, e.g. the herrings and their relatives.

Phytelephas (family Palmae) Genus of palms in which the stem is short, stout, and often procumbent. The leaves are large and pinnate. The flowers are dioecious. The inflorescences are stout, and held in unbranched spadices. The fruits form in big, knobbly heads, and the endosperm is hard. *P. macrocarpa* (ivory nut), is the principal source of vegetable ivory used for carving. *Phytelephas* species are very different from other palms. There are 15 species, occurring in northern tropical America.

phytic acid (hexaphosphoinositol) Substance stored in some seeds.

phyto-alexin Antifungal substance produced by a plant in response to damage or infection; phyto-alexins may help to protect the plant from disease.

phytochrome Photoreversible pigment, which occurs in every major taxonomic group of plants. It exists in two interchangeable forms with respect to absorption, a red and a far-red form. This phenomenon is utilized in plants as a switch mechanism, linked to environmental light signals, to control many activities in plants. These include flowering, germination, vegetative growth, circadian rhythms, and many more physiological activities.

phytocoenosis *See* biocoenosis.

phytogeography The study of the geography of plants, particularly their distribution at different taxonomic levels, e.g. family, genus, and species. Patterns of distribution are interpreted in terms of climatic and anthropogenic influence, but above all in terms of earlier continental configurations and migration routes. This branch of biogeography is also known as floristics.

phytohormone *See* plant hormone.

phytol Long-chain alcohol that comprises the major side-chain of chlorophyll.

Phytolacca (pokeweed; family Phytolaccaceae) Genus of N. American herbs with flowers borne in leaf-opposed racemes, and producing purple berries. It is sometimes cultivated.

Phytolaccaceae Family of trees, shrubs, herbs, or woody climbers. The leaves are entire and alternate, the flowers regular, with a single perianth of four or five usually separate segments, four to many stamens, and 1–16 carpels, free or united below. There are 15 genera, and about 100 species, largely confined to the tropics.

Phytomastigophorea (superclass Mastigophora) In protozoan classification, a class of plant-like microscopic organisms which possess chloroplasts and are photosynthetic. These organisms are often regarded as algae. They are found in soil, shallow ponds, lakes, seas, etc.

Phytomyza ilicis *See* Agromyzidae.

phytoncide Substance which is produced normally by a plant and which has some antimicrobial action; phytoncides may play a role in preventing disease in the plant.

phytopathology The study of plant diseases.

phytophagous Feeding on plants.

Phytophthora (family Pythiaceae) Genus of fungi, many of which are plant pathogens of great economic importance (e.g. *P. infestans* causes late blight of potato and can also infect other plants of the Solanaceae). There are about 40 species.

phytoplankton The plant plankton and primary producers of aquatic ecosystems, comprising mainly diatoms in cool waters with dinoflagellates being more important in warmer waters.

Phytosauridae Sole family of the order Phytosauria, a subclass of the Archosauria ('ruling reptiles'). They were specialized thecodonts similar to crocodiles in general shape. They date from the latter part of the Triassic, and inhabited N. America, Europe, and India. They were displaced by the crocodiles at the end of the Triassic.

phytosociology The description of plant communities, more especially their classification based primarily on floristic rather than life-form or other considerations. The most renowned and extensively used phytosociological scheme is that developed by J. Braun-Blanquet (1927 and later) and his associates at Zurich and Montpellier. A similar, fairly widely applied scheme was developed by G. E. du Rietz (1921 and later) and others at Uppsala.

Phytotomidae (plantcutters; order Passeriformes) Family of stocky, finch-like birds, with grey-brown, streaked backs, some of which have a chestnut crown and orange under-parts. Their short wings have white wing bars, and their long tails are white-tipped. Their bills are stout, with serrated edges. They inhabit woodland, open scrub, and gardens, feed on fruit, buds, and leaves, and nest in bushes. There is one genus, *Phytotomus*, with three species, found in S. America.

phytotoxin Substance produced by a plant pathogen that is toxic to plants.

piassava (African bass) Fibre obtained from petioles of the palm *Raphia vinifera* by retting. Brazilian piassava is obtained similarly from *Leopoldinia*. *See Raphia*.

picarel (*Spicara smaris*) *See* Emmelichthyidae.

Picathartidae (bald crows, rockfowl; order Passeriformes) Family of medium-sized birds which have grey upper-parts, white under-parts, and characteristically bare heads with yellow and black, or red, blue, and black skin. They have stout bills and fairly long tails, and rounded wings. They inhabit dense forest; feed on insects and amphibians; and build mud nests on the walls of caves. There is one genus, *Picathartes*, with two species, found in W. Africa. They are often placed in the family Timaliidae.

Picea (spruce; family Pinaceae) Genus of large, evergreen conifers. The leaves are stiff and are borne singly on peg-like projections which remain attached to the twig when the leaves fall. The cones are borne at the tips of the branches and hang downward when ripe. The genus includes many important timber trees, e.g. *P. sitchensis* (Sitka spruce). There are about 50 species, found throughout the northern hemisphere except in Africa.

Picidae (woodpeckers; order Piciformes) Family of small to large, black, white, yellow, red, brown, or green birds, some of which are crested and many of which have yellow or red on the head. Most have long, stout bills, used for drilling holes; and long, fine tongues used for feeding. Their wings are short and rounded, and their tails are usually wedge-shaped with stiff feather shafts. Their legs are short, and their feet are zygodactylous with three or four toes. They are arboreal; climb tree trunks

for insects, fruit, and sap; and nest in tree cavities, banks of earth, and termite mounds. There are 27–35 genera, and about 200 species, found worldwide.

Piciformes (jacamars, puffbirds, barbets, honeyguides, toucans, woodpeckers; class Aves) Order of small to fairly large birds which have brightly coloured plumage. The bills of each family are stout and characteristically shaped, their toes zygodactylous. They are mainly arboreal, feed on vegetable matter and animals, and nest in holes; one family is brood parasitic. There are six families, found worldwide.

Picoides (woodpeckers; family Picidae) Genus of small to medium-sized woodpeckers, which have black, brown, and white patterned plumage, males having red or yellow crowns. They have four toes, except for two species which have three. They are arboreal; feed on insects and fruit; and nest in tree holes. There are 33 species, but the 31 species of four-toed birds are often placed in a separate genus, *Dendrocopos*. They are found in Europe, Africa, Asia, and N., C., and S. America.

Picornaviridae Family of viruses which contain one linear, single-stranded, RNA molecule. The virions are icosahedral and are not enveloped. They can cause disease, e.g. common cold, foot-and-mouth (hoof-and-mouth) disease, and poliomyelitis.

Picrodontidae (order Primates, suborder Plesiadapiformes) Extinct family of prosimians which lived during the Palaeocene. They are believed to have been an evolutionary offshoot from the main line of primate evolution and to have no later descendants.

piculets *See Picumnus*.

Picumnus (piculets; family Picidae) Genus of small woodpeckers which have brown or green backs, black tails with a white central stripe, and the males of which have a red or yellow forehead. They have short bills, not used for drilling, and their tails do not have stiffened shafts. They inhabit forests, feed on insects, and nest in holes in trees. There are about 25 species, found in S. America, and one in SE Asia.

Picus (woodpeckers; family Picidae) Genus of medium-sized, mainly green woodpeckers which have barred under-parts. Most have red on the head, some are crested, and some have orange or red on their wings. They are arboreal. Many feed on the ground on ants, and nest in holes in trees. There are 15 species found in Europe, N. Africa, and Asia.

Pieridae (white butterflies, jezebels, orange tips, brimstones, sulphur butterflies; order Lepidoptera) Family of medium-sized butterflies with predominantly white or yellow wings, in which the white colour is derived from uric acid-based waste products. Some species are migratory. Eggs are laid singly or in groups. The larvae are not spined, but have fine setae. The pupa is supported by a central silk girdle.

Pieris brassicae (large white butterfly, cabbage white butterfly; order Lepidoptera, family Pieridae) Medium-sized butterfly in which the adult is predominantly white and has black markings. The under-sides of the hindwings are yellow. The larva is a pest of Cruciferae, particularly cabbage and brussels sprouts. The butterfly is found in Europe, including Britain, and N. Africa.

pig *See* Suidae.

Pigafetta (family Palmae) A monotypic palm genus, *P. filiaris* is a lofty, pinnate-leaved palm of disturbed forest, with solitary glistening trunks. It is dioecious. The inflorescences are axillary, the fruits scaly. It grows fast. It is a splendid, little-known ornamental, which occurs in central Malesia.

pigeon pea (*Cajanus cajan*) *See Cajanus*.

pigeons 1 *See Columba*; Columbidae; Columbiformes. 2 (green pigeons) *See Treron*. 3 (imperial pigeons) *See Ducula*. 4 (passenger pigeon, *Ectopistes migratorius*) *See* Columbidae. 5 (rock dove, *Columba livia*) *See Columba*.

pigfish *See* Congiopodidae.

pightle Small enclosure, especially one that is adjacent to a house.

pigment Compound (biochrome) that produces colour in the tissues of living organisms. The biological function of the compound may or may not be directly associated with this property.

pika (*Ochotona*) *See* Ochotonidae.

Pikaia gracilens Worm-like animal from the mid-Cambrian Burgess Shales of Canada, which is known to have had a rod of tissue (or notochord) along its back and blocks of muscular tissue similar to those of *Amphioxus*. It is probable that *Pikaia* is an animal closely related to the first vertebrates.

pike *See* Esocidae.

pike characin (*Hepsetus odoe*) *See* Hepsetidae.

pike conger *See* Muraenesocidae.

pikehead (*Luciocephalus pulcher*) *See* Luciocephalidae.

pilchard (*Sardinia pilchardus*) *See* Clupeidae.

pileus From the Latin *pileus* meaning 'cap'. 1 (taxon.) The fleshy or leathery structure upon which hymenium-bearing tissue occurs in a fungal fruit body, e.g. the cap of an agaric. 2 (meteor.) An accessory cloud occurring as a small cap on or above a cumuliform cloud. Caps may occur one on top of another. The cloud is associated with cumulus or cumulonimbus. *See also* cloud classification.

pilidium larva In Nemertinea, a free-swimming larva which develops directly from the gastrula.

pill beetle *See* Byrrhidae.

pill bugs *See* Armadillidae; *Armadillium vulgare*; and Isopoda.

Pilobolaceae (order Mucorales) Family of fungi in which the sporangia have dark coloured, persistent walls and contain many spores. In *Pilobolus* the sporangia are discharged forcibly by a jet of liquid. There are three genera, and several species, found on the dung of herbivores.

Pilosa (order Edentata, suborder Xenarthra) Infra-order comprising the sloths and ant-eaters, classified as three superfamilies: Megalonychoidea (ground sloths, now extinct); Myrmecophagoidea (ant-eaters); and Bradypodoidea (tree sloths). Members of the Pilosa possess fur and are contrasted with the armadillos of the infra-order Cingulata.

pilose Covered with fine hairs or down.

pilot whale (*Globicephala melaena*) *See* Delphinidae.

Pimelea (family Thymelaeaceae, subfamily Thymelaeoideae) Genus of shrubs and some herbs, with small leaves which are opposite, or widely spaced along the stem. The bisexual flowers are protandrous, held in terminal or axillary heads, and are rarely solitary. The calyx is fused and cylindrical with four lobes, the two stamens being attached to the tube. The ovary is unilocular, and the small fruit is enclosed in the base of the calyx. The seeds contain no endosperm, but have a tough testa. Several species are adapted to arid conditions, and form component species of heathland. Others are found in alpine areas and have developed a cushion-like habit, with a reduced, aerial shoot. There are 85 species, found only in Australasia, 80 of which are present in Australia.

Pimelodidae (long-whiskered catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Very large family of freshwater catfish with elongate and scaleless bodies; a small dorsal fin; a long adipose fin; and three pairs of barbels around the lips. Most species are nocturnal, but some, e.g. *Pimelodus clarias* (pintado), 20 cm, have been used as aquarium fish. There are 285 species, occurring in S. America.

Pimelodus clarias (pintado) *See* Pimelodidae.

Pimenta (family Myrtaceae) Genus of small, aromatic, evergreen trees which are functionally dioecious. *P. dioica* yields pimento, or allspice, made from the dried, unripe fruits. It is exported solely from Jamaica. There are five species, occurring in tropical America.

Pinaceae (order Coniferales) Family of conifers with both male and female cones, and with the seeds borne between the cone scales, with no fleshy arils. The leaves are spirally arranged and linear. The cone scales are arranged spirally, each cone scale in female cones being a double structure with the ovule-bearing scale borne in the axil of a bract which is fused to it only at the base. Female cone scales each bear two inverted ovules on their upper surfaces. Male cone scales each bear two pollen sacs on their lower surfaces, containing pollen grains each with (usually) two bladder-like sacs. There are nine genera, comprising some 180 species, occurring in the northern temperate zone.

pinacocyte In Porifera, one of the flattened cells which comprise the outer surface and which can be expanded or contracted at their margins to allow the whole animal to alter its size slightly. At the base the pinacocytes secrete a substance which anchors the sponge to its substrate.

Pinanga (family Palmae) Genus of palms which grow in forest undergrowth, and are locally abundant. They are solitary or form clumps. The leaves are entire or pinnate, and the crown-shaft is prominent. The inflorescence is simple or sparsely branched, two male flowers flanking a female. The fruiting spikes and fleshy fruits are of bright, contrasting colours. There are 120 species, occurring from India to Taiwan and New Guinea.

pincate beetle *See* Tenebrionidae.

pine 1 *See Pinus*. 2 (Japanese umbrella pine) *See Sciadopitys*.

pineapple (*Ananas comosus*) *See Ananas*.

pine-barren An area of pine forest, in which the various species of pine usually produce small or medium-sized trees. The barrens coincide with poor, sandy, and to a lesser extent marshy soil, and owe their ecological character in part to centuries of burning. They occur in the SE USA, on the coastal plain of the Atlantic and Gulf of Mexico, from New Jersey to Florida, excluding its southern tip, and into Texas.

pinecone fish *See* Monocentridae.

pine marten (*Martes martes*) *See* Mustelidae.

pine-tree katydids *See* Tettigoniidae.

pin-frame Device for obtaining a quantitative estimate of vegetation cover. Pin-frames are typically made from lightweight wood, aluminium, or plastic and comprise a cross-bar with pin-holes supported on legs of adjustable height. The pin-frame is set up so that the cross-bar sits above the vegetation to be sampled. Pins are lowered through the pin-holes and the plants hit by the pin-tips are recorded. Where the vegetation is of variable height, records of top-cover (the first plant encountered by the pin) and bottom-cover may be taken. The pin diameter used will affect the results and must be standardized for comparative work.

pingo Ice-cored, dome-shaped hill, oval in plan, standing 2–50 m high, and 30–600 m in diameter. The larger examples have breached crests in which ice may be exposed. They are probably due to local freezing of water that has migrated from adjacent uplands or to the late freezing of the ground beneath a lake. *See also* palsa.

Pinguicula (butterwort) *See* Lentibulariaceae.

Pinguinus impennis (great auk) *See* Alcidae.

pink *See Dianthus*.

pinna 1 In Mammalia, an extension of the external ear to form a trumpet-like structure, often mobile, supported by cartilage. 2 One of the leaflets of a pinnate leaf. 3 Fin, or fin-like limb.

pinnacle reef *See* reef.

pinnate Of leaves, compound, with leaflets displayed on either side of a central stalk or rachis. The main nerves of most leaves are pinnate, arising along the midrib.

pinnate batfish (*Platax pinnatus*) *See* Ephippidae.

Pinnipedia (superorder Ferae, order Carnivora) Suborder comprising the families Otariidae (sea lions), Odobenidae (walrus), and Phocidae (seals), together with their immediate ancestors. The families may not be related closely, the classification being based on similarities of appearance and way of life that may result from convergence. All are marine carnivores in which the digits are fully webbed and, with the limbs, modified to form paddles. The hind limbs are directed to the rear while swimming, and are used for propulsion. Teeth are reduced in number.

pinnule The ultimate division of a fern frond.

pinocytosis Process similar to phagocytosis (by which a cell membrane can invaginate and enclose externally derived, solid material within a vacuole, without disrupting the continuity of the cell surface, the vacuole subsequently fusing with a lysosome and its contents being wholly or partly digested), except that the material enclosed is a liquid.

pinta Human disease found in C. and S. America. Symptoms include the appearance of patches of discoloration or depigmentation on the skin. The causal agent is *Treponema carateum*.

pintado (*Pimelodus clarias*) *See* Pimelodidae.

Pinus (true pines; family Pinaceae) Genus of resinous, evergreen conifers with the leaves (needles) borne in groups of twos, threes, or fives on short shoots borne along the twigs. There are separate male and female cones, the latter with woody scales; the seeds are winged. Many pines are important for timber, also yielding resin and turpentine. There are some 70–100 species, all in the northern hemisphere, occurring mainly in northern temperate regions, extending in America and E. Asia to the seasonal tropics. The common name 'pine' is sometimes used to describe other pine-like trees of different genera, e.g. *Araucaria araucana* (Chile pine or the monkey-puzzle tree), or, loosely, to include all conifers.

Pinus aristata (bristlecone pine) Pine species from California, famous for its longevity and used to develop an exceptionally long arid-site tree-ring chronology. The oldest living specimens date back more than 4600 years, but cross-dating these with remnants of dead bristlecone pines has extended the arid-site chronology to more than 8200 BP. A 5500-year chronology has been developed for bristlecone pines at the upper tree limit. These pines are also used to calibrate the radiocarbon-dating method to allow for fluctuations in atmospheric ^{14}C : ^{12}C ratios as revealed by measuring ^{14}C : ^{12}C ratios of individual tree rings in the long, absolutely dated, tree-ring series. *See also* cross-dating; and dendrochronology.

Pinus contorta* var. *latifolia (lodgepole pine) Tall ornamental tree of N. America, which yields a useful timber.

Pinus palustris (American pitch pine) *See Pinus*.

pioneer phase Stage in the cyclical pattern of community change in heathlands, when individual *Calluna vulgaris* plants are young (up to 10 years old) and provide little cover, so that there is maximum diversity of associated species. Although *C. vulgaris* biomass is low, productivity in the new shoots is high. *Compare* building phase; degenerate phase; hollow phase; and mature phase. The term may also be used more generally for the 'new plant' stage of any cyclical pattern of vegetation change.

pioneer plants *See* succession.

pioneer stage General term describing the early stages of a plant succession. *See* succession.

pipal-tree (bodh-tree, *Ficus religiosa*) *See Ficus*.

Pipa pipa (Surinam toad; order Anura (Salientia), suborder Aglossa, family Pipidae) A flat-bodied toad, which has a small, triangular head, webbed hind-feet, and long, sensitive fingers used for scavenging in the mud. Its young develop encapsulated in the female's back, hatching already metamorphosed, in 77–136 days. It is distributed through Brazil and the Guianas.

pipefish *See* Syngnathidae.

Piper (family Piperaceae) Genus of herbs, slender climbers, shrubs, and small trees. The twigs have swollen nodes. The leaves have stipules, commonly trinerved. The flowers are held in spikes, are hermaphrodite, and have no sepals or petals. The fruit is a berry. Pepper is the fruit of *P. nigrum*; the betle pepper is *P. betle*; and kava, a mild narcotic of Melanesia, is *P. methysticum*. There are 2000 species, with a pantropical distribution.

Piperaceae (peppers) Family of small trees, shrubs, and climbers, in which the leaves are alternate, simple, and entire, with stipules, and glands containing an aromatic oil. The petioles are winged, and sheath the nodular, jointed stem. The stem form is a result of sympodial growth. The flowers are small, bisexual or unisexual, and held in spikes or racemes opposite the leaves. The ovary is unilocular and superior, with up to four fused carpels surrounded by scale-like bracts, but there is no calyx or corolla. The fruit is a small, fleshy drupe with a single seed, often sunk into the stem. The vascular bundles are peculiarly arranged for a dicotyledon, often being irregularly scattered through the stem. *Piper nigrum* yields the condiment pepper, and is widely cultivated. The fruit is gathered early, and dried to give black peppercorns, or, if the outside is removed, white pepper. *P. methysticum* is kava, a narcotic which, when pulped and fermented in water, gives the national Polynesian sedative drink. There are four genera, found throughout the tropics and represented in most rain forests. The major genus is *Piper*, which contains more than 2000 species, most of which are climbing shrubs. The remaining three genera contain a total of 84 species.

Piper betle (betle pepper) *See Piper*.

Piper methysticum (kava) *See* Piperaceae.

Piper nigrum *See* Piperaceae.

pipe snakes *See* Aniliidae.

Pipidae (pipid toads, clawed toads; order Anura (Salientia), suborder Aglossa) Family of tongueless toads, in which the lateral-line organs are distinct, and important in prey detection. There are 5–8 opisthocoelous (near-concave) vertebrae. The family includes the pipids of S. America and the clawed toads of Africa. There are 11 species, all aquatic in muddy waters.

pipid toads *See* Pipidae.

piping 1 Subsurface erosion of channels by water in unconsolidated earth materials (e.g. the washing out of a channel or tunnel in a dam, eventually causing leakage or failure). 2 Pattern of surface channels that transmit precipitation down hillslopes. Normally developed at the junction between the permeable A horizon and the impermeable B horizon. 3 The process giving rise to this pattern.

pipistrelle (*Pipistrellus pipistrellus*) *See* Vespertilionidae.

Pipistrellus pipistrellus (pipistrelle) *See* Vespertilionidae.

pipits *See Anthus*; and Motacillidae.

pipkrake *See* needle ice.

Pipra (manakins; family Pipridae) Genus of mainly glossy, black or green manakins, the males of which have bright red, blue, yellow, and white heads or crowns, and brightly coloured thighs. They inhabit forest and undergrowth, feed on berries and insects, and nest in bushes. There are 16–18 species found in C. and S. America.

Pipridae (manakins; order Passeriformes) Family of small, stocky, short-tailed birds which have short, broad, slightly hooked bills, and short wings. Their short legs have the centre toe fused basally to the second or fourth toe. They are mainly black, with coloured heads and crowns. They inhabit tropical forests, feed on fruit and insects, and nest in bushes. There are 18 or 19 genera, comprising about 60 species, found in C. and S. America.

Piptocephalidaceae (order Mucorales) Family of fungi in which the sporangia are cylindrical in shape and contain a single row of spores. There are two genera, and many species. They are parasitic on other fungi, usually on other members of the Mucorales.

Piptoporus (family Polyporaceae) Genus of fungi which form thick fruit bodies in which the surface is initially covered by a fine tomentum. *P. betulinum* is common on dead and dying birch trees (*Betula* species). The fruit body is bracket-like and semi-circular to hoof-shaped, with a thick, rounded margin; the upper surface bears a thin greyish or brownish skin which may separate from the white flesh. There are five other species. *See also* razor-strop fungus.

Piranga (tanagers; family Thraupidae) Genus of mainly red tanagers, some males of which have black wings, white wing bars, and yellow, grey, or green bodies. The females are yellow-green. Tanagers are arboreal, feed on fruit, and nest in trees. There are nine species, some migratory, found in N., C., and S. America. Two species have occurred as vagrants in Britain.

piranha *See* Characidae.

Piroplasmea (subphylum Sporozoa) Class of protozoa which are parasitic in a range of vertebrates, where they infect red and white blood cells, and cells of the liver. A second (invertebrate) host is required for completion of the life cycle. There is one order, with two families. The class includes some important pathogens of domestic animals.

Pisauridae (nursery-web spiders; order Araneae, suborder Araneomorphae) Family of medium to large spiders, with long legs. The females carry the egg sac in the chelicerae and spin a nursery web tent for the hatchlings, which disperse after their second moult. The males often offer nuptial gifts. *Pisaura* is a common European genus found in grass, and species in the genus *Dolomedes* (2–3 cm long) are among the largest northern species, often living near ponds where they may catch small fish.

Pisces Superclass containing the four classes of fish, including the two extant classes Chondrichthyes (cartilaginous fish, e.g. sharks) and Osteichthyes (bony fish), the extinct Placodermi and Acanthodii, and also the most primitive of the vertebrates. The first protofish are known from late Cambrian fossils, and the first true fish, an agnathan, has been recorded from earliest Ordovician sediments. Some modern classifications omit the term 'Pisces', regarding it as artificial. *See also* Gnathostomata.

pisciculture *See* fish culture.

Pisonia (family Nyctaginaceae) Genus of plants in which the leaves are usually opposite. The flowers are usually unisexual, and small. The seeds are sticky, clinging to bird feathers and thus dispersed; they are used as bird-lime. There are 50 species, occurring in the tropics and subtropics.

pistachio (*Pistacia vera*) *See Pistacia*.

Pistacia (family Anacardiaceae) Genus of plants that includes *P. terebinthus* which yields chian turpentine, and *P. vera*, the source of edible pistachio nuts. There are 10 species, occurring in the subtropics.

Pistia (family Araceae) Genus of one species, *P. stratiotes*, a floating water plant which has a sympodial series of leaf rosettes. The inflorescences are tiny. It is a noxious weed which occurs throughout the tropics and subtropics.

pistil Gynoecium of a syncarpous flower; each carpel in an apocarpous one.

pistillode A sterile, often reduced pistil.

piston sampler *See* peat-borer.

Pistosaurus grandaevus A likely ancestor for all plesiosaurs although it is known only by its skull. It bears some similarities to both nothosaurs and plesiosaurs, and is found in rocks of Middle Triassic age.

Pisum (garden pea; family Leguminosae) Genus of annual herbs. Many species climb by means of leaf tendrils. The leaves are compound, with paired oval leaflets. The flowers are zygomorphic with a distinctive petal arrangement: a large upright back

petal and two smaller wing petals enclose a cup-like keel petal. The round seeds are borne in a long pod, and expelled explosively. *P. sativum* (garden pea) and other species are grown for their edible seeds and sometimes pods, used as a protein source for humans and livestock. They can be dried for storage. There are about six species, occurring in the Mediterranean region and W. Asia.

pita (*Aechmea magdalenae*) *See Aechmea*.

pitchblende *See* uraninite.

pitcher plants *See Nepenthes*; and Nepenthaceae.

Pithecellobium (family Leguminosae, subfamily Mimosoideae) Genus of trees in which the leaves are pinnate, the stipules sometimes thorny. The pod is commonly coiled and dehiscent. Some species have edible seeds. There are 60 species with a pantropical distribution.

pit organ Temperature-sensitive organ.

Pitta (pittas) *See* Pittidae.

pitted-shell turtle *See* Carettochelyidae.

Pittidae (pittas; order Passeriformes) Family of small, plump, brightly coloured, short-tailed birds, which have short, rounded wings, and strong, slightly curved bills. Their legs are long, and their feet large. They are secretive, solitary, and terrestrial, and can hop rapidly. They inhabit jungle and forest scrub, feed mainly on insects, and build rounded nests with side entrances, placed on the ground or in low bushes. There is one genus, *Pitta*, containing 25 species, some migratory, found in Africa, Asia, and Australia.

Pittosporaceae Family of evergreen shrubs, trees, and a few climbers whose leaves are alternate, leathery, and without stipules. The bark is resinous. The flowers are bisexual, regular, and pentamerous. The fruit is a capsule or berry. There are nine genera, comprising more than 200 species, occurring in the Old World tropics but strongly concentrated in Australasia.

Pittosporum (parchment bark, Australian laurel; family Pittosporaceae, tribe Pittosporeae) Genus of evergreen shrubs and small trees which have leathery, entire leaves without stipules. The flowers are bisexual, regular, terminal axillary or lateral, and in five parts. Both the sepals and petals are united at the base. The stamens are attached to the calyx. The ovary is superior, with two or more fused carpels, is single or multilocular, and has a simple style. The fruit is a leathery capsule with numerous seeds which are sometimes sticky. Several species give a valuable timber, and many are cultivated as ornamentals, with coloured, fragrant flowers, and attractive foliage. There are 150 species, found in tropical and subtropical Africa, Asia, and Australasia. Many of the species are very restricted in distribution. All the Australian species are endemic, and 26 species are endemic to New Zealand. They are mainly present in rain forests, but some species have adapted to arid conditions.

pituri *See Duboisia*.

pit vipers *See* Crotalidae.

pityriasis versicolor Disease of humans, caused by the fungus *Pityrosporum orbiculare* (*Malassezia furfur*). Areas of the skin become scaly and discoloured.

Pityrosporum (family Cryptococcaceae) Genus of imperfect, yeast-like fungi found on the skin of humans and other animals. It can cause skin disease.

Pitys antiqua Early member of the gymnosperm order Cordaitales, recorded from the Upper Carboniferous of Scotland. The Cordaitales dominated Upper Palaeozoic floras with trees attaining a height of 30 m.

placenta 1 In flowers, the part of the ovary wall, formed from the fused margins of the carpel or carpels, on which are carried the ovules. 2 In mammals, the organ by which embryos of viviparous species are nourished, and waste products removed, formed by the fusion of embryonic and maternal tissues.

placentation The position of the placenta within the carpel; it may be parietal (on the walls), axile (on the axis), basal, or free-central.

placer deposit Deposit of precious materials (e.g. gold, diamonds, tin, or platinum) that has been concentrated by mechanical action. Placer minerals generally have high density and resistance, and therefore may concentrate during various types of weathering.

placic horizon Subsurface soil horizon, formed most readily in humid tropical or cold conditions, that is cemented by iron and organic matter, by iron and manganese, or by iron alone.

Placodermi Class of archaic, jawed (gnathostome), and heavily armoured fish, which appeared in the Devonian and which were virtually extinct by the end of that period. They were rather diverse in body form. They all possessed a head shield formed by bony plates. Pectoral and pelvic fins appear to have been present. Most of them (e.g. *Coccosteus*) were bottom-dwelling fish, with a depressed body terminating in a heterocercal tail.

placodioid Applied to a lichen thallus which is roughly circular and crustose, with a determinate margin and radiating peripheral lobes.

Placodontidae Triassic euryapsid reptiles, which were specialized shellfish feeders. Some were heavily armoured and strongly resembled turtles; while the more lightly armoured varieties, e.g. *Placodus*, were analogous in general form to the nothosaurs, except for the modifications relating to their molluscan diet.

Placodus impressus One of the best-known representatives of a strange, specialized group of Triassic marine reptiles. Notable features include the development of large flat teeth on the palate and lower jaws; webbed fingers and toes; and an elongate tail. *P. impressus* was adapted to feeding on shell banks. Later representatives of the placodont reptiles were more turtle-like in their morphology.

placoid scale (dermal denticle) Type of scale that comprises the basic unit of the hard skin cover of sharks. It consists of a hard base embedded in the skin and a spiny process (cusp); these are covered by a hard, enamel-like substance (vitrodentine), and the scale projects outwards and backwards. It is these cusps that are responsible for the roughness of the shark's skin. The bulk of the denticle consists of dentin surrounding a central pulp cavity. Unlike the scales of bony fish, placoid scales stop growing after they reach a certain size and new denticles are added instead.

Placynthiaceae (order Lecanorales) Family of lichens in which the thallus is scaly-crustose to minutely fruticose; in most species the phycobiont is a cyanobacterium. The spores usually have two or more transverse septa. There are several genera, found on stones, soil, mosses, etc.

plaggen A man-made soil horizon more than 50 cm deep, resulting from long-continued manuring, often enriched by phosphate.

Plagiochila (order Jungermanniales) Genus of leafy liverworts including *P. porelloides* (formerly *P. asplenioides*) which is common in moist, shady habitats. The shoots are robust (2–10 cm long), erect or ascending, and little branched. The leaves are large, and overlap in the succubous arrangement. Each leaf is broad and rounded and often minutely toothed. *P. porelloides* is dull green, and found on banks, in woods, on rocks and walls, etc., especially on neutral or calcareous substrates.

plagioclimax (biotic climax) 'Plagioclimax' and 'biotic climax' are almost synonymous terms, which are sometimes given different meanings. Generally, they both refer to a stable vegetation community arising from a succession that has been deflected or arrested either directly or indirectly as a result of human activities. An important distinction exists between these two cases. In a deflected succession the resulting stable community, even when composed entirely of native species, is one that would not have occurred had the disturbing human intervention not taken place. For example, the lowland heath communities of Britain and W. Europe arose as a consequence of forest clearance and subsequent grazing pressure and controlled burning. Associated changes in the physical environment may mean that even when these pressures are removed succession to the original climax community is no longer possible. In an arrested succession, the stable community is a naturally occurring successional phase: following removal of the disturbing factor, continuation of the natural succession should be possible. For example. the cutting of reed beds arrests the natural succession to alderwood in a hydrosere. Some authors restrict the term 'plagioclimax' to deflected successions; some use 'plagioclimax' where human intervention is more direct, reserving 'biotic climax' for more indirect effects, such as grazing by non-domesticated but introduced animal species, e.g. rabbit in Britain. 'Biotic climax' may also be applied to a natural, undisturbed succession in which the final community form is determined by a naturally occurring biological agent, e.g. grasslands on guano-enriched coastal areas.

plagiogeotropic *See* geotropic.

plague 1 In general, any epidemic of a disease in which the death rate is very high. 2 More specifically, and more usually, a disease of humans caused by *Yersinia pestis* (formerly *Pasteurella pestis*). The disease occurs in several forms. Bubonic plague is the commonest form. In pneumonic plague the lungs are severely affected and mortality rates are very high. Septicaemic plague involves septicaemia and is also frequently fatal. *Y. pestis* is harboured by rats and is transmitted to humans by fleas.

plains-wanderer *See* Pedionomidae.

planarians *See* Tricladida.

planation surface 1 Synonym for erosion surface. 2 The final stage in the erosion of folded sedimentary rocks, when inverted relief is planed across by erosion.

Planchonella (family Sapotaceae) Genus of rainforest trees whose timber is hard, heavy, and sometimes siliceous (nyatoh). There are 100 species, one in the Seychelles, two in America, the rest in the eastern tropics.

Planctosphaeroidea (phylum Hemichordata) Extant class of an unknown type of hemichordate, based on two specimens of larvae found in the Bay of Biscay.

planetary boundary layer The layer of the lower atmosphere extending to a height of about 500 m above the ground, in which frictional effects of the underlying surface generate turbulence. *See also* turbulence; and turbulent boundary layer.

planetesimal hypothesis A cataclysmic theory, propounded early in the twentieth century, to explain the origin of the solar system. This was attributed to tidal interactions produced by a close encounter between the Sun and a star. The immense gaseous tides produced in the Sun pulled matter away, in the direction of the star, to form a long, gaseous filament. This then broke into several parts, each contracting to form a planet.

plane tree *See Platanus*.

planèze Sloping triangular facet on the flank of a volcano, underlain and protected by lava. Its form is a result of the radial dissection by streams of a complex volcanic cone.

plank A piece of sawn timber.

plankton Minute aquatic organisms that drift with water movements, generally having no locomotive organs. The phytoplankton (plants) comprise mainly diatoms, which carry out photosynthesis and form the basis of the aquatic food-chains. The zooplankton (animals) which feed on the diatoms may sometimes show weak locomotory powers. They include protozoans, small crustaceans, and in early summer the larval stages of many larger organisms. Plankton are sometimes divided into net-plankton (more than 25 μm diameter) and nano-plankton, which are too small to be caught in a plankton net.

planktonic geochronology The use of planktonic organisms, e.g. globigerinid foraminiferids or microscopic algae, to provide a relative dating of sediments deposited in marine waters. Radioactive-decay methods applied to planktonic organisms may also yield an absolute date or information on palaeoclimates.

planogamete A motile gamete.

planospore A motile spore.

plan position indicator (PPI) Radar display in which the echo from a target appears as a bright mark against a dark field, its position on the screen indicating the direction and distance of the target from the scanner.

plantain-eaters *See* Musophagidae.

plant association (association) Term loosely applied in the classification of vegetation communities and given varying interpretations in different phytosociological traditions, with resulting confusion. The current most widely accepted usage follows the Zurich–Montpellier school. In this, the 'association' is the basic vegetation unit, an abstract entity, floristically defined from field data or relevés. Each association has a distinctive faithful species and a group of high-presence or constant species which give the community or association a cohesive structure. Often these companion species of the association form the faithful species of the next and succeeding hierarchical levels, alliances, and orders into which similar associations are grouped. In British and American traditions, 'association' has tended to imply a community with physiognomic as well as floristic unity, usually a climax community in which the species dominants are those of the upper vegetation layer. In this tradition an association usually has several co-dominant species. The term 'consociation' is reserved for single-species dominance. *See also* formation; and phytosociology.

plantation Area of woodland comprising trees that have been planted by humans.

plantcutters *See* Phytotomidae.

plant formation *See* formation.

plant hopper *See* Delphacidae.

plant hormone (phytohormone) Compound synthesized by a plant, and not a nutrient, coenzyme, or detoxification product, that regulates growth, differentiation, or other specific physiological processes. It is classically defined as being 'made at one site and functioning at another'; but in fact it is made by various tissues, transported actively or passively, and affects most tissues within the plant.

plantigrade In land-dwelling vertebrates, applied to a gait in which the sole of the foot makes contact with the ground. Such a gait is less specialized than one in which the heel is raised from the ground and does not permit such rapid acceleration.

plants *See* Metaphyta.

plant sociability In the description and analysis of plant communities, a measure of the distribution pattern and organization of a species. The Zurich–Montpellier phytosociological scheme uses a five-point sociability scale: sociability (1) growing once in a place, singly; (2) grouped or tufted; (3) in troops, small patches, or cushions; (4) in small colonies, extensive patches, or forming carpets; and (5) in great crowds, or pure populations.

planula In Coelenterata, applied to a free-swimming, ciliated, elongated, radially symmetrical larva.

plaque A round, clear area forming on an otherwise opaque culture plate of bacteria as a result of their lysis by a bacteriophage (virulent virus). Temperate phages produce turbid plaques because of the growth of lysogenic bacteria on the floor of the plaque.

plasmagene (plasmid) Cytoplasmic particle, found in bacterial cells, that carries one or more genes and that can replicate itself autonomously. Genetic information on the plasmid is passed from each cell to its daughter cell, and sometimes to neighbouring cells. Plasmids normally remain separate from the chromosome, but some plasmids may become integrated temporarily into the chromosome (and therefore replicated with it incidentally). Plasmids are important in the genes that they carry: these may for example confer upon the bacterial host resistance to some antibiotic, thus rendering the drug ineffective in combating that bacterium, and thus drug resistance can spread, e.g. in a hospital ward.

plasmalemma *See* cell membrane.

plasma membrane A sheet-like structure that encloses the protoplasm of a cell and delimits it from its environment. It is a living structure, 7.5–10 nm thick, that acts as a selectively permeable barrier in all cells. It may also have other functions, as in prokaryotic cells, where it is associated with oxidative metabolism and cell division. *See also* cell membrane.

plasma thromboplastin component (PTC) *See* blood clotting.

plasmid *See* plasmagene.

plasmodesmata Cytoplasmic bridges, lined with a plasma membrane, that connect adjacent cells. At one time they were thought to be confined to plants, but they have now been observed in many animal cells. Almost certainly they provide major pathways of communication and transport between cells.

Plasmodiidae (suborder Haemosporina) Family of parasitic protozoa, which undergo schizogony in the red blood cells, as well as in the cells of other tissues, in a vertebrate host. The life cycle requires the participation of a mosquito vector. There is one genus, *Plasmodium*.

Plasmodiophora (class Plasmodiophoromycetes) Genus of micro-organisms which includes *P. brassicae*, the causal agent of club-root in cruciferous plants.

Plasmodiophorales (class Plasmodiophoromycetes) Order of micro-organisms, which have the characteristics of the class. The order includes a single family, with nine genera and 35 species, some of which are important plant pathogens.

Plasmodiophoromycetes Class of microscopic, obligately parasitic, eukaryotic organisms in which the thallus is holocarpic and consists of naked, multinucleate, amoeboid protoplasm (a plasmodium). The plasmodium occurs only inside the cells of various vascular plants, fungi, or freshwater algae. The class contains a single order, Plasmodiophorales.

Plasmodium (family Plasmodiidae) Genus of parasitic protozoa, which includes some very important disease-causing species: the malarial parasites. The life cycle is complex. Some stages can occur only in a second host, the mosquito vector. The genus includes more than 50 species, of which four (*P. vivax*, *P. falciparum*, *P. ovale*, and *P. malariae*) cause malaria of differing degrees of severity in humans. Other species infect various other vertebrates, including monkeys, birds, and reptiles.

plasmodium In acellular slime moulds, a vegetative (feeding) structure consisting of a non-cellular, mobile mass of naked protoplasm containing many nuclei.

plasmolysis The result of placing plant cells in a hypertonic solution (e.g. about 10% sugar solution) so that water is drawn out of the cell: the cytoplasm shrinks and the cell membrane is pulled away from the cell wall.

plasmotomy Type of asexual reproduction in which a multinucleate protozoan cell divides into two or more multinucleate daughter-cells without the occurrence of mitosis.

plastic growth The part of cell-wall extension that is irreversible.

plastic limit *See* Atterberg limits.

plastid One of a group of double-membrane-bound plant-cell organelles which vary in their structure and function. This broad categorization includes such organelles as chloroplasts, leucoplasts, amyloplasts, etc.

plastocyanin Acidic protein containing two copper atoms per molecule, that acts as an electron carrier, linking photosystems I and II during photosynthesis.

plastoquinone Derivative of quinone that acts as an electron carrier, linking photosystems I and II during photosynthesis.

plastron 1 In Chelonia (Testudines), the lower part of the shell, which is two-layered, consisting of bony plates corresponding to part of the shoulder girdle and abdominal ribs of primitive reptiles, covered by horny epidermal plates. It is joined to the carapace (the top of the shell) by a bridge between the legs. In some families it is hinged. 2 In some insects, a physical gill made up of hydrofuge hairs. Insects which use a plastron when diving under water are covered with a thick felt of hairs which are bent over at the tips. The hairs trap a layer of air which is continuous with the tracheal system, and surrounds the animal.

Platacanthomyidae (Chinese pygmy dormice, spiny dormice; order Rodentia, suborder Myomorpha) Family of arboreal mice, which resemble dormice, but have long, bushy tails. They are sometimes referred to the Muridae as a subfamily. The first digit of the forelimb is reduced to a pad, and the hind feet are elongated. There are two species, in two genera. In *Platacanthomys* (spiny dormouse) the fur is spiny. In *Typhlomys* (Chinese pygmy dormouse) the eyes are very small, the fur is soft, and the tail is poorly haired, and scaly at its base. They are found only in S. India and S. China.

Platalea (spoonbills; family Threskiornithidae) Genus of large, long-necked, long-legged, mainly white birds which have a long, horizontally flattened bill which has a broad, spatulate tip. They are gregarious, inhabit freshwater areas, and feed on fish and aquatic invertebrates caught by sweeping the bill from side to side. They nest colonially in bushes and trees. There are five species found in Europe, S. Asia, Africa and Australasia.

Platanaceae Family of deciduous trees which comprises only one genus, *Platanus*.

Platanistidae *See* Platanistoidea.

Platanistoidea (order Cetacea, suborder Odontoceti) Superfamily comprising the one family Platinistidae, the river dolphins, cetaceans which are believed to be related closely to the squalodonts and to forms known from the early Miocene, and to be more primitive than other Odontoceti. The temporal opening is unroofed. The beak is long and slender, the teeth peg-like, and varying in number according to species. The cervical vertebrae are not fused, and the neck is distinct. The flippers are broad and short, the dorsal fin low, and the tail slightly notched at the midline. River dolphins grow to a length of 1.5–2.9 m. There are five species in four genera. *Platanista*, which is blind, is found in the Indus, Ganges, and Brahmaputra rivers of India, and there are two species; *Inia* inhabits the Amazon and upper Orinoco rivers of S. America; *Pontoporia* is found in the estuary of the La Plata river, and along the south-east coast of S. America; *Lipotes* is found only in Lake Dongting, on the Chang (Yangtze) Jiang, in China.

Platanus (plane tree; family Platanaceae) Genus of deciduous trees, which have flaking-off bark, buds enclosed in petiole bases, and alternate, stipulate, palmately-lobed leaves. The flowers are tiny, in several globular heads arranged along a stalk and forming a catkin, each catkin either of male or female flowers. Male flowers each have 3–5 stamens within a tiny cup, female flowers have 5–9 carpels in a calyx cup. Numerous hairs surround the nutlets in the globular fruiting heads. It is the only genus of its family, with some six species in SE Europe, SW Asia, and N. America. It is much planted, especially in towns.

Platax pinnatus (pinnate batfish) *See* Ephippidae.

plated lizards *See* Cordylidae.

plate margin The boundary of one of the tectonic plates that together cover the surface of the Earth. Plate margins are characterized by the presence of volcanic, tectonic, and seismic activity.

Plateosaurus gracilis Species of Triassic prosauropod which grew to approximately 6–7 m in

length and weighed two tonnes. Current theory suggests that the prosauropods were a side-branch on the sauropod family tree, rather than the ancestors of reptiles such as *Diplodocus* and *Apatosaurus* (*Brontosaurus*).

plate tectonics The unifying concept that has drawn continental drift, sea-floor spreading, seismic activity, crustal structures, and volcanic activity into a coherent model of how the surface of the Earth evolves. It proposes a lithosphere composed of discrete, rigid plates underlain by a less rigid aesthenosphere over which movement is possible. Plates are constantly forming and separating, and so being enlarged, at constructive margins (ridges), while the global circumference is conserved by the subduction of material at destructive margins (trenches).

Platyarthrus hoffmannseggii (ant woodlouse; order Isopoda, suborder Oniscidea, family Squamiferidae) Species of terrestrial woodlouse, about 5 mm long, which lives as a symbiont of ants in their nests, although it can survive in the absence of ants. Normally it feeds on detritus, ant faeces, fungal spores, and honeydew from plant louse colonies. Ant woodlice are able to smear defensive secretions on the mandibles of a biting ant. The species occurs chiefly in Europe, but individuals have been found in nests of *Formica* in the eastern USA.

Platyasterida (starfish; class Stelleroidea, subclass Asteroidea) Order of starfish, characterized by the arrangement of arm ossicles in transverse rows, from axial elements (adambulacrals, ambulacrals) laterally. Only one row of marginal ossicles is present. There are three genera, two Palaeozoic and one Recent.

Platycephalidae (flathead; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of marine fish which are characterized by the possession of a distinctly depressed or flattened body; a large mouth; a flat head with the eyes located on top; and pectoral fins that project sideways. Many species are attractively coloured, and often well camouflaged when lying on the sea-bottom. Flatheads are of commercial importance in many countries of the Indo-Pacific region. *Platycephalus fuscus* (dusky flathead), 1.2 m, and *P. richardsoni* (tiger flathead), 45 cm, are among the more commonly caught species in temperate Australian waters. There are about 55 species, occurring in the Indo-Pacific region.

Platycephalus fuscus (dusky flathead) *See* Platycephalidae.

Platycephalus richardsoni (tiger flathead) *See* Platycephalidae.

Platycerium (family Polypodiaceae) Genus of ferns which have naked superficial sori on erect, forked, antler-like, fertile fronds. Sterile, broadly oval or rounded fronds bend down over the rhizomes and help to trap humus beneath them. They are epiphytes of tropical rain forests, especially in Africa.

Platychthys flesus (flounder) *See* Pleuronectidae.

Platycnemidae (damselflies; order Odonata, suborder Zygoptera) Ubiquitous family of damselflies whose members are characterized by having an almost rectangular discoidal cell in the wing venation, and only two postquadrilateral cells before the subnodus. The tibia of the middle and hind legs are often dilated, especially in the male. The nymphs are generally short and broad, with thickened caudal gills. More than 200 extant species have been described.

Platyctenea (class Tentaculata) Order of ctenophorids which have dorsoventrally compressed bodies and two retractable tentacles. Some can swim, but most move by creeping or are sessile.

Platygasteridae (suborder Apocrita, superfamily Proctotrupoidea) Family of minute (1–2.5 mm long), shiny black wasps which have a more or less flattened abdomen and almost no wing venation. Adults are very similar to Scelionidae, and the larvae are parasites of cecidomyid gall midges and some whiteflies. Some larvae are egg parasites of Fulgoridae (Homoptera) and Coleoptera. The family includes *Platygaster*, a genus parasitic on the hessian fly and other gall midges, and *Inostemma*, whose females carry their long ovipositor in a handle-like process which extends forward over the thorax. Reproduction by polyembryony is widespread in the family.

Platyhelminthes (flatworms) Phylum of acoelomate, bilaterally symmetrical worms in which the internal organs are well developed and metameric segmentation is absent. The gut may be present, but skeletal elements are rare. Morphologically they are quite diverse, and many are parasites. Most are hermaphrodites. The phylum lacks a definitive fossil record. From various evolutionary considerations it is probable that platyhelminths were in existence 800–1000 million years ago.

platypus (*Ornithorhynchus anatinus*) *See* Ornithorhynchidae.

platyrrhine In Primates, applied when the nostrils face more or less to the sides and are well separated.

Platyrrhini (New World monkeys; cohort Unguiculata, order Primates) Although the platyrrhine (S. American) monkeys are often grouped with the catarrhine (Old World) monkeys, apes, and humans into one suborder, Anthropoidea, the two kinds of monkeys remain distinct as far back as the Oligocene, when they first enter the fossil record. Much of their resemblance is therefore the result of parallel evolution, following independent derivation, probably from tarsioid stock. Accordingly, modern classification often gives separate subordinal status to New World and Old World monkeys. *See also* Catarrhini.

Platysternidae (big-headed turtles; order Chelonia (Testudines), suborder Cryptodira) Family of turtles which consists of a single species, *Platysternon megacephalum*, found in mountain brooks in SE Asia. The jaws are serrated. The head is too large to withdraw into the shell. The carapace is flattened. The tail is long, and plated. *P. megacephalum* is an aquatic carnivore, but often travels over land.

Platysternon megacephalum (big-headed turtle) *See* Platysternidae.

Platystictidae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies in which the basal cross vein of each wing traverses the cell bounded by the second branch of the cubitus, the arculus, and the hind margin of the wing. There are also many postnodals. There are more than 130 described extant species found throughout Asia and C. and S. America. *See also* venation.

play Voluntary, seemingly paradoxical behaviour (i.e. a goal usually associated with the behaviour is not attained because the activity is not pursued to its conclusion, or because it is misdirected), often occurring in bouts preceded by signals exchanged between participants, during which movements may be performed in apparently random succession, and in which certain sequences may be repeated many times.

playa The lowest part of an intermontane basin, or bolson, in the arid basin-and-range province of the western USA. It is frequently flooded by run-off from the adjacent highlands, or by local rainfall. Sediments consist largely of colloids, clays, and evaporites, e.g. halite, gypsum, and sodium sulphate. The surface is generally flat, with mud-flats, and locally small dunes.

pleasing fungus beetles *See* Erotylidae.

pleated sheet Structural configuration normally found in fibrous proteins, in which polypeptide chains are partially extended and held together by inter-chain bonds between >NH and >CO groups on all peptide bonds.

Plecoglossidae (ayu; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Monospecific family of fish, including only *Plecoglossus altivelis*. In Japan, and to some extent China, the ayu is a commercially important species. Although ayu spend some time in the sea, they return to freshwater streams to spawn. Large numbers of juveniles are caught during their annual migration, and are stocked in ponds for cultivation. They occur in N. Asia.

Plecoglossus altivelis (ayu) *See* Plecoglossidae.

Plectognathi Alternative name for fish placed in the order Tetraodontiformes.

Plectomycetes (subdivision Ascomycotina) Class of fungi in which the walls of the asci are evanescent, and the ascocarp typically is a globose cleistothecium. Three orders are sometimes recognized. They are chiefly saprotrophic, and are found in a wide range of habitats.

Plectonema (order Nostocales) Genus of filamentous cyanobacteria which can carry out nitrogen fixation. They are often difficult to distinguish from *Lyngbya* and *Phormidium* (the LPP group). They are found in aquatic environments and on soil. Species growing on soil help to bind together soil particles and prevent erosion.

Plectronoceras cambria One of the first nautiloids, which was small, and horn-shaped. As its name suggests, the species is discovered in rocks of Cambrian age, in Europe and Asia.

pleiotropy The phenomenon of a single gene being responsible for a number of different phenotypic effects that are apparently unrelated.

Pleistocene The first of two epochs of the Quaternary, preceded by the Pliocene. It is held conventionally to have lasted from approximately 1.8 million years ago until the beginning of the Holocene, about 10 000 years ago, but recent evidence from deep-sea cores may necessitate a revision of the earlier date. The epoch is marked by several glacial and interglacial episodes in the northern hemisphere.

Pleistocene refugium Favourable area where species have survived periods of glaciation during the Pleistocene Era. Such species are termed relicts.

pleomorphism The ability of an organism to exist in different forms or shapes.

pleopod In Crustacea, one of a number of abdominal appendages used for swimming, burrowing, obtaining food, carrying eggs, or making water currents; or in gas exchange. In males, the anterior one or two pairs are copulatory organs.

Pleosporales (class Loculoascomycetes) Order of fungi which form perithecium-like pseudothecia. Pseudoparaphyses are interspersed among the asci. They are found as parasites or saprotrophs on plants, etc.

Plesiadapidae (order Primates, suborder Plesiadapiformes) Extinct family of primates which lived during the Palaeocene and Lower Eocene, and are known mainly from fossils found in W. America. *Plesiadapis*, which is typical, had ears and molar teeth reminiscent of those of lemurs, but the incisors were chisel-like, and the digits possessed claws rather than nails. It was a squirrel-like animal with fore and hind limbs of equal length. The plesiadapids represent an evolutionary branch which died out, and they are not ancestral to any of the higher primates.

Plesiadapiformes (order Primates) Extinct suborder comprising the families Paramomyidae, Plesiadapidae, Carpolestidae, and Picrodontidae, which are the earliest known Primates, and which flourished during the Palaeocene. Most are known only from the most fragmentary remains, mainly of teeth and parts of jaws, though a few skulls and even partial skeletons are known, and apart from the fact that they are Primates their relationship to later forms is uncertain. Probably most were too specialized to have given rise to later Primates, despite their geologically ancient occurrence.

Plesiadapis Genus of squirrel-like primates recorded from the Palaeocene and Lower Eocene of Europe and N. America. It was already too specialized to be the ancestor of the lemurs. *See also* Plesiadapidae.

Plesiadapoidea Suborder of Middle Palaeocene to Lower Eocene primates which resembled squirrels in their general appearance and, like squirrels, occupied a rodent-type niche. They are not in line of descent to the higher primates.

Plesiocidaroida (class Echinoidea) Order of small, regular echinoids, characterized by having a very

large apical system and ambulacra which, at the peristomal margin, begin with a single plate followed by three plates. The peristome is large and lacks gill slits. This small group is known only from Upper Triassic rocks of alpine Europe.

plesiomorph Primitive (of a character state); the opposite of apomorph.

plesiomorphic Applied to features that are shared by different groups of biological organisms and are inherited from a common ancestor. The term means 'old-featured' and the features to which it is applied were formerly called 'primitive'.

Plesiopidae (roundhead, devilfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have a fairly deep body; a large head with a large mouth; a single, continuous dorsal fin; and a rounded tail-fin. The first half of the lateral line runs close to the base of the dorsal fin. Several species, e.g. *Paraplesiops bleekeri* (Bleeker's devilfish), 30 cm, are quite colourful. They tend to hide near rock ledges. The family is distributed in the Indo-Australian region.

Plesiopora (phylum Annelida, class Oligochaeta) Order of mainly small annelid worms among which ciliated forms are common. They are aquatic. Microscopic forms are free-living, others are tube-dwellers. There are four families.

Plesiosauroidea Suborder of aquatic reptiles which enter the fossil record in the late Triassic, and which are common in many Jurassic and Cretaceous sediments. In appearance they have been likened to 'a snake strung through the body of a turtle', and some grew up to 15 m in length. There were also short-necked types, as well as the swan-necked. The former are defined as the superfamily Plesiosauroidea, the latter as the superfamily Pliosauroidea, the two making up the suborder.

plesiosaurs *See* Plesiosauroidea.

Plethodontidae (lungless salamanders; class Amphibia, order Urodela (Caudata)) Family of amphibians in which the adults usually lack gills and lungs. They are characterized by a naso-labial groove, a glandular extension from the upper edge of the lower lip, below the nostril. They are mainly aquatic, and the family includes mountain-brook and blind, cave-dwelling forms; but some are terrestrial, e.g. burrowing worm salamanders. There are 183 species, found in S. Europe, and N., C. and S. America as far as 20° S.

Pleurobranchomorpha *See* Notaspidea.

Pleurocapsales (division Cyanobacteria) Order of cyanobacteria which form both erect and prostrate filaments. There are no heterocysts. Multiplication occurs by the formation of baeocytes ('endospores'). They are found for example on stones in freshwater and marine environments.

pleurocarpous moss Type of moss in which archegonia, and hence capsules, are borne on short, lateral branches, and not at the tips of stems or branches. Pleurocarpous mosses are usually monopodially branched, often pinnately so, and tend to form spreading carpets rather than erect tufts. *Compare* acrocarpous moss.

Pleurodira (side-necked turtles; order Chelonia (Testudines)) Suborder of chelonians which withdraw the head into the shell by bending the neck sideways. There are two families, found primarily in the southern hemisphere, in freshwater habitats.

pleurodont *See* acrodont; and Iguanidae.

Pleuronectidae (right-eye flounder; class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Large family of marine flatfish, comprising the true flounders, which have the eyes on the right side, the dorsal fin starting above the upper eye, a fairly large mouth with distinct teeth, and the right pectoral and pelvic fins mostly larger than the left ones. The family includes many commercially important species, e.g. *Reinhardtius hippoglossoides* (Greenland halibut), 1 m, with annual catches of more than 100 000 tonnes in the N. Atlantic, *Platichthys flesus* (flounder), 50 cm, and *Pseudopleuronectes americanus* (Atlantic winter flounder), 60 cm. There are about 100 species, distributed in the Atlantic and Pacific.

Pleuronectiformes Order of marine flatfish which have a highly compressed and asymmetrical body. The eyes are on the right or left side of the body. The newly-hatched larvae have a normal, symmetrical fish shape, but begin to assume the peculiar flatfish features when they are about 2 cm long. The order comprises about six families, with some 520 species.

Pleuronematina (order Hymenostomatida) Suborder of ciliate protozoa in which body cilia usually are sparse. Usually there is a single, prominent, caudal cilium. A conspicuous row of oral cilia, constituting an 'undulating membrane', extends from one side of the cell. Pleuronematina are found in marine or freshwater aquatic environments.

pleuropneumonia-like organisms (PPLO) Prokaryotic organisms belonging to the class Mollicutes.

pleurothetic Applied to a resting position common in members of the pelecypod order Ostreina (oysters), in which individuals settle on to the substrate on their sides.

Pleurotremata Alternative, older name for the sharks, but excluding the rays (Hypotremata).

Pleurotus (family Tricholomataceae) Genus of fungi which form fleshy, gilled fruit bodies. The stipe is short and usually eccentric, or absent. *Pleurotus* species are found mostly on wood, and some are edible. *See also* oyster fungus.

Pleurozia (order Jungermanniales) Genus of leafy liverworts, of which *P. purpurea* is typical. It is a robust, distinctive plant with prostrate primary stems from which arise leafy shoots that are more or less erect, and deep purplish-red. Each leaf consists of two parts. One part is large, concave, with a shallowly cleft and toothed tip. The other part is much smaller, deeply concave and hooded; a flap at the base acts as a valve, allowing water to enter but preventing its escape. Microscopic animals may become trapped in these tiny 'pitchers' and may act as an additional source of nutrients for the

liverwort. The species is common on wet, peaty heathland and moorland in W. Scotland and Ireland.

plexus In data analysis, a diagram in which the lengths or widths of interconnecting lines reflect the relative similarity of the samples. It provides a useful visual presentation of similarity/dissimilarity indices.

plicate 1 Folded or wrinkled. 2 *See* vernation.

plinthite (ironstone, laterite) Portion of mineral soil containing a large proportion of iron and aluminium oxides, clay, and quartz, which has developed through a combination of leaching and gleying in well-weathered tropical soils. On drying, it changes irreversibly to an ironstone hardpan.

Pliocene The last of the Tertiary epochs, which began five million years ago and lasted for approximately two million years.

Pliosauroidea *See* Plesiosauroidae.

Ploceidae (weavers, sparrows; order Passeriformes) Family of small, stocky birds which have short, stout bills. The weavers are mainly black with yellow, red, or brown. Sparrows are mainly brown. Some members of the genus *Euplectes* have long tails. Many are gregarious, inhabit forest, grassland, and cultivated land, and feed on seeds and insects. Many build elaborate woven nests, suspended from trees, with a long entrance tunnel. Others build untidy nests in trees, grass, and buildings. Some are parasitic and most are colonial. There are 17–19 genera, comprising 145 species, many kept as cagebirds, found in Europe, Africa, Asia, Australasia, and the Pacific islands. *Quelea quelea* (red-billed quelea) is the most numerous bird in the world, numbering thousands of millions.

Ploceus (weavers; family Ploceidae) Genus of mainly black and yellow birds, many of which have black heads and faces. They are gregarious, inhabit woodland and grassland, feed on seeds and insects, and build woven nests of a variety of shapes, suspended from branches. Most are colonial. There are about 56 species, many kept as cagebirds, found in Africa and S. Asia.

Ploiarium (family Bonnetiaceae) Genus of small, bushy, evergreen trees in which the flowers are borne in terminal clusters, with stamens in five bundles, and opposite petals. The fruit is a capsule. There are three species, occurring from SE Asia to New Guinea.

plotless sampling Sampling without the use of quadrats. Individual pin-frame records may be regarded as plotless samples. Plotless sampling is most often used for surveys of forest vegetation, especially where a rapid inventory is needed. Various approaches have been developed, e.g. the nearest-neighbour sampling method.

plough-bote Timber that is used for the construction or repair of farm implements, carts, or tools. 'Bote' means 'bounty' or 'gift'.

plovers *See* Charadriidae; *Charadrius*; *Pluvialis*; and *Vanellus*.

plug *See* volcanic plug.

Plumbaginaceae Family of annual and perennial herbs, shrubs, and climbers, many of which are halophytes. The leaves are simple, either in a basal rosette or alternately placed along a branched stem. They have water or chalk glands in their surface, and no stipules. The inflorescence is a cyme, raceme, spike, or densely clustered head, with the bracts sometimes forming an involucre. The flowers are bisexual and regular, with the parts in fives. The calyx is fused, five-lobed, and often coloured. The petals are free or basally fused. The stamens are either free, or fused in the base of the corolla, and placed opposite the petals. The ovary is superior, with five fused carpels, and unilocular. The stigmas and styles are in fives. The fruit is a nut, usually enclosed in the persistent calyx, with the seeds containing a floury endosperm. Several species are of medicinal value, and many are grown as ornamentals, particularly in rock or scree gardens. There are 10 genera, with about 600 species, found throughout the temperate and tropical regions, mainly in dry or saline habitats.

plume moth *See* Pterophoridae.

Plumeria (family Apocynaceae) Genus of small trees which includes *P. rubra* (frangipani), which has flowers with a heavy fragrance and is widely cultivated in the East. The genus comprises seven species, found in the warm regions of America.

plumose hair The branched type of body hair found in bees, which is adapted to pick up and retain pollen grains when a bee brushes against the anthers (male parts) of flowers.

plum pox (sharka disease) Disease of plum and related trees whose symptoms are variable according to the plant species, but which usually include the appearance of pale or dark rings or spots on leaves and fruit. Plum pox is a disease of considerable economic importance, and is a notifiable disease in Britain. It is caused by a virus and is transmitted by aphids.

plums *See Prunus*.

plunging breaker Wave that breaks vertically, so that its crest falls into the preceding trough and encloses a pocket of air. The wave form is then lost. Typically it occurs when a fairly low wave approaches a steep shingle beach.

plush-capped finch (*Catamblyrhynchus diadema*) *See* Catamblyrhynchidae.

Pluteus (family Pluteaceae, order Agaricales) Genus of fungi in which the spore print is pink to cinnamon-coloured. The fruit bodies are mushroom-shaped and lack both volva and annulus. The gills are not attached to the central stipe. There are many species, found mainly on rotting wood.

pluton General term applied to a body of intrusive igneous rock, irrespective of its shape, size, or composition.

pluvial Prolonged phase of markedly wetter climate that occurs in a normally dry or semi-arid area.

Pluvialis (plovers; family Charadriidae) Genus of medium-sized waders whose upper-parts are spangled grey and black, or yellow-brown and black. The

under-parts are black in the breeding season. They have medium-length, stout bills. They breed in upland and tundra areas, wintering on grassland and coastal estuaries. They feed on invertebrates and nest on the ground. There are three species, breeding in N. America, Europe, and Asia, and migrating to S. America, Africa, and Australia.

pneumatolysis The changes in rock brought about by the action of hot gases, rather than water, which frequently are associated with igneous activity. Exotic mineral phases may develop as a result of this kind of activity.

pneumatophore Specialized 'breathing' root developed in some plant species that grow in waterlogged or strongly compacted soils, e.g. mangroves. The aerial part of the root contains many pores, enabling gas exchange with the atmosphere. Internally a well-developed system of intercellular spaces allows gases to diffuse throughout the submerged portion of the roots.

pneumococcus Common name for the bacterium *Streptococcus pneumoniae*, one of several causal agents of pneumonia.

pneumonia Inflammation of the lungs. Pneumonia may or may not be caused by microbial infection. Bacteria which may be responsible include *Streptococcus pneumoniae*, *Haemophilus influenzae*, and others; viruses may also be responsible.

pneumonic plague *See* plague.

Pneumoridae (class Insecta, order Orthoptera, suborder Caelifera) Family of grasshoppers in which the abdomen of the male is inflated, and bears lateral, stridulatory ridges. The hind legs are relatively small. There are about 20 species, which occur in S. Africa.

Poa (meadow grasses; family Gramineae, subfamily Pooideae, tribe Poeae) Genus of grasses which have compound panicles, and glabrous leaves. The spikelets are keeled, and usually of 2–5 florets. The lemma is keeled and nerved, often with a tuft of long, soft hairs arising from the base, and usually with a hyaline tip, and no awn. The lemma is longer than the awnless glume. There are three stamens with long anthers, and a short, terminal style. *P. annua* (annual meadow grass) is thought to be the most widely distributed and the commonest grass species in the world. It is found in all regions, but in the tropics is restricted to mountainous areas. There are about 200–300 species, found in all temperate and cool regions, and at higher altitudes in the tropics. Many species are valuable pasture grasses.

Poa annua (annual meadow grass) *See Poa*.

poached soil *See* puddled soil.

poachers *See* Agonidae.

pochard *See Aythya*.

pock Eruptive pustule which develops on the skin of animals. It is a symptom of certain diseases, e.g. smallpox.

pocket gopher *See* Geomyidae.

pocket mice *See* Heteromyidae.

pocket rot Type of timber decay in which the decay occurs in small, distinct areas or pockets. *Heterobasidion annosum* is an important cause of white pocket rot in both conifers and hardwoods.

pod Fruit that dehisces down both sides into two separate valves, which are most typically dry and somewhat woody. Pods are the characteristic fruit of the Leguminosae.

Podarcis (wall lizards; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Genus of typical lacertids, comprising the wall lizards and similar forms. Their scalation is similar to that of members of the genus *Lacerta*. The hemipenis of the male has large sulcal lips. There are 13 species, occurring in Europe, NW Africa, and SW Asia.

Podarcis muralis (wall lizard; order Squamata, suborder Sauria (Lacertilia) family Lacertidae) Slender lizard which grows to 23 cm. It frequently basks on walls and rocks. Its colour is variable, spotted, or with a network; sometimes there is a vertebral stripe. It inhabits C. and S. Europe, and is native to Jersey. There are several introduced colonies in Britain.

Podarcis sicula (Italian wall lizard, ruin lizard; order Squamata, suborder Sauria (Lacertilia), family Lacertidae) Lizard, which grows to 25 cm. Usually it is bright green with a dark, blotched, vertebral stripe or network (the latter in the south of its range). It is oviparous. It is a common Italian species, extending to NW Yugoslavia and S. Switzerland.

Podargidae (frogmouths; order Caprimulgiformes) Family of brown, grey, and black, cryptically coloured birds which have broad, flat, hooked bills with a wide gape and basal bristles. They have medium-length, rounded wings, and a long tail. They are nocturnal, inhabit forest and bush, and feed on insects and small mammals caught on the ground. They nest in tree forks. There are two genera, comprising 13 species, found from SE Asia to Australia.

podetium In certain lichens (e.g. *Cladonia*), a fruticose portion of the thallus upon which ascocarps (when present) are borne. A podetium may or may not be branched, and may be cup-shaped, awl-shaped, etc.

Podiceps (grebes; family Podicipedidae) Genus of small to large grebes, many of which have coloured ear tufts. Larger species have long necks and bills. They inhabit freshwater lakes, many migrating to the coast in winter. There are 11 species, found in Europe, Africa, Asia, Australia, New Zealand, and N., C., and S. America. Many C. and S. American species are confined to isolated lakes, and are endangered.

Podicipedidae (grebes; order Podicipediformes) Family of medium to large diving birds which are grey or dark brown above, and many of which are white below. Many have ear tufts and crests. Their legs are positioned at the rear of the body, and their feet are lobed and partially webbed. Their wings are

small, some birds being practically flightless, and many have white secondaries. They have short to long, pointed bills, and most have long necks. They inhabit freshwater lakes in summer, and some move to coastal waters in winter. They feed on fish and invertebrates, and nest on a platform of vegetation in the water. There are five genera, comprising 20 species, found in Europe, Africa, Asia, Australasia, N., C. and S. America. *See also* primaries.

Podicipediformes (grebes; class Aves) Order which comprises one family, Podicipedidae.

Podocarpaceae Family of conifers largely confined to the southern hemisphere, with a few species extending north across the equator in Africa and S. America. The seeds are borne inverted, singly or in pairs, not in cones, and each seed has a fleshy aril or a fleshy receptacle and stalk. The pollen grains are winged. There are six genera, comprising about 86 species.

Podocarpus (family Podocarpaceae) Genus of evergreen trees and shrubs which are dioecious, and whose mature seeds are fleshy, solitary, and often enclosed in the fleshy, enlarged receptacle. They yield valuable timber. There are 100 species, occurring in southern temperate regions and extending north into the tropics.

Podocarpus totara (totara) New Zealand timber tree with great importance in Maori mythology.

Podophyllum (family Boberidaceae) Genus of herbs, which are closely related to the Berberidaceae. The fruit is a berry, with the seeds enveloped in the enlarged placenta. The rhizome resin provides a drug used to treat warts. There are 10 species occurring in E. Asia, and one species (May apple) in N. America.

Podopteryx mirabilis Named 'marvellous foot wing', this is the species that is the probable ancestor of the pterosaurs. Unlike them it was a glider, relying on the large membrane stretched between its hind legs and tail. It is known from the Lower Triassic of Soviet Kirghizstan.

Podostemaceae Family of aquatic herbs, whose structure is often modified into a thallus with anchoring roots. The flowers are tiny, bisexual, regular, and reduced. The fruit is a capsule. They are locally common and conspicuous, especially in tropical America, and rare and disjunct in the eastern tropics. They may be related to the Saxifragaceae. There are 45 genera, comprising 130 species, occurring mainly in the tropics where they are confined to swiftly flowing rivers.

podsol *See* podzol.

podsolization *See* podzolization.

podzol (podsol) Soil profile formed at an advanced stage of leaching by the process of podzolization, and identified by its acid mor humus, eluviated and bleached E horizon, and an iron-coloured B horizon, enriched with a variety of translocated materials. *See also* Spodosols.

podzolization (podsolization) Advanced stage of leaching, podzolization is the process of removal of iron and aluminium compounds, humus, and clay minerals from the surface soil horizons by an organic leachate solution, and the deposition of some of these translocated materials in lower B horizons.

Poecilia reticulata (guppy) *See* Poeciliidae.

Poeciliidae (livebearer, guppy; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Large family of freshwater and brackish-water fish which are of small size: they generally inhabit freshwater streams, but several species can be found in saline coastal marshes. They all have an elongate body form, a single, soft-rayed dorsal fin on the middle of the back, with the anal fin opposite in mid-ventral position. The tail-fin is always rounded, and the pelvic fin often small. Many poeciliids are easy to breed and display beautiful colour patterns in aquariums. Perhaps the most famous is *Poecilia reticulata* (guppy) which, with its many colour varieties, has decorated numerous aquariums all over the world. Other species include, *Gambusia affinis* (mosquitofish) and *Xiphophorus helleri* (green swordtail). There are about 138 species, occurring in C. and S. America.

Poecilosclerida (class Demospongiae, subclass Ceractinomorpha) Order of sponges which have a skeleton of spicules, or organic fibres, or both. The dermis is often very specialized, as are the spicules and their arrangement. Many spicules are cemented together. This is a very large order which first appeared in the Cambrian.

pogge (*Agonus cataphractus*) *See* Agonidae.

Pogonophora Phylum comprising deep-sea worms, first encountered in early Cambrian rocks.

Pohlia (order Bryales) Genus of mosses in which the plants are usually tufted. The leaves are ovate to lanceolate, and are more crowded towards the stem apex. Capsules are ovoid to ellipsoid and erect to pendulous. *Pohlia* is a cosmopolitan genus containing about 155 species. *P. nutans* is a very common British species. The shoots are green or yellowish-green, up to 7.5 cm tall, with stems tomentose below. In spring and summer the unripe capsules are conspicuous: they are bright green and pendulous, and borne on long red setae. They are found on peaty or sandy soil, and on decaying wood, and are calcifuge.

Poikilospermum (family Urticaceae) Genus of shrubs and climbers which are somewhat intermediate to the Moraceae. There are 20 species, occurring from the Himalayas to Malesia.

poikilotherm (exotherm) Organism that regulates its body temperature by behavioural means, e.g. by basking or burrowing. Such animals are often termed 'cold-blooded', although when active their body temperature is little different from that of homoiothermic ('warm-blooded') animals. Poikilothermy is characteristic of lower vertebrates (fish, amphibians, and reptiles), but not of birds and mammals. *Compare* homoiotherm.

point bar *See* bar.

point mutation Mutation that can be mapped to one specific locus: it is caused by the substitution of one nucleotide for another.

point quadrat Quadrat sampled by the pin-frame method.

poison beetle *See* Chrysomelidae.

poison ivy (*Rhus toxicodendron*) *See Rhus*.

Poisson distribution The basis of a method whereby the distribution of a particular attribute in a population can be calculated from its mean occurrence in a random sample of the population, provided that the population is large and the probability that the attribute will occur is less than 0.1. For a given mean the distribution can be calculated, giving the probabilities that a sample will contain 0, 1, 2, 3, ... examples of the particular attribute. The distribution is named after the French mathematician S. D. Poisson (1781–1840).

pokeweed (*Phytolacca*) *See* Phytolaccaceae.

polar air Air mass originating in latitudes 50–70°, which may have a maritime or continental source. Maritime polar air has high relative humidity, is warmed in its passage equatorward or over warmer seas, and becomes unstable. Continental polar air is stable in its source region and is associated with very cold surface conditions in winter, e.g. Siberian air moving across Europe.

polar-air depression Non-frontal depression in the northern hemisphere, which typically results from the southward movement of unstable polar or arctic maritime air along the eastern side of a large-scale meridional high-pressure ridge. *See also* cold low.

polar body The minute cell produced during the development of an oocyte (either primary or secondary): it contains one of the nuclei derived from the first or second meiotic divisions, but very little cytoplasm.

polar climate Climatic type associated with regions inside the Arctic and Antarctic Circles. A gradation of climatic characteristics exists towards the poles, from tundra conditions to those of perpetual frost. *See also* Köppen climate classification.

polar desert soil Mineral soil without identifiable horizons, and with almost no surface humus. It is associated with arid, polar desert environments where precipitation is less than 130 mm annually, plant cover less than 25%, and thawed, active soil 20–70 mm deep.

polar front The main boundary line between polar and tropical air masses along which the depressions develop in mid latitudes, especially over the oceans. The front is in general displaced equatorwards in winter and polewards in summer, though large displacements in either direction take place over shorter periods in individual sectors of the hemisphere.

polar-front jet stream The jet stream observed in different positions over middle and higher latitudes at heights of 10–13 km, and associated with the boundary zone between polar and tropical air above the polar front. Maximum velocity averages 60 m/s, but can be twice this in extreme cases. The jet is typically discontinuous but at times can extend almost around the globe. It is more persistent in winter in response to the stronger temperature gradient between north and south than in summer. The jet is related to the development of surface frontal depressions of middle latitudes. *See also* jet stream.

polar glacier *See* cold glacier.

polar locular Applied to the spores of certain lichens, which have two cells separated by a partition that is perforated by a thin pore or channel.

polar molecule Molecule in which, though it does not carry a net electric charge, the electrons are unequally shared between the nuclei. In the water molecule, for example, the pull of the oxygen nucleus on the shared electrons is greater than the pull of the hydrogen nuclei. As a result the oxygen end of the molecule is slightly negatively charged, and the hydrogen ends of the molecule are each slightly positively charged. The molecule is said to have a dipole moment and can attract other molecules with a dipole moment.

polar nuclei Two haploid nuclei inside the mid-region of the embryo sac of a flowering plant which fuse with another nucleus (one of two sperm nuclei) to form the triploid endosperm.

polar transport The movement in one direction within a plant, basipetally in shoots, of plant growth substances and plant growth regulators by a mechanism that requires metabolic energy and that does not involve intact xylem or phloem streams.

polar wander The apparent movement of the Earth's magnetic poles during geological time; it is due to the actual movement of the lithospheric plates.

pole Single-trunked tree that is smaller and usually lower than a standard. A coppice pole is a stem arising from a coppice stool.

pole capsule In Sporozoa, bodies located at one end of the cell and containing a long filament by means of which the spore can attach itself to the host.

Polemoniaceae (phloxes) Dicotyledonous family, mainly of perennial and annual herbs, but including some shrubs, climbers, and trees. The leaves are simple or compound, opposite or alternate, without stipules. They are glabrous or with short hairs. The inflorescence is a cyme or a solitary flower, and either axillary or terminal. The flowers are regular and bisexual, with five sepals and five petals. The calyx is a fused tube, and the corolla is fused into a bell-shape or a plate-shape. The five stamens are fused to the corolla tube. The ovary is superior, usually of three fused carpels and three locules, each with one or more ovules. The style is simple, with a three-lobed stigma. The fruit is a capsule, which splits to distribute the numerous, endospermic seeds. The testa is often sticky when wet. The pollination of the plants is usually carried out by bees, but several species rely on specific pollinators, such as hummingbirds, bats, hawkmoths, and other Lepidoptera. Many species, including *Phlox*, are cultivated for their showy flowers. There are five tribes within the family,

mostly separated in their distribution. There are 18 genera, comprising more than 300 species, found mainly in N. America, but with tropical species in C. America, and other species in Europe, N. Asia, and western S. America.

poliomyelitis Disease in which poliovirus infection of the spinal cord leads to inflammation of the grey matter. Symptoms range from mild gastrointestinal or respiratory disturbance to paralysis and death.

Polioptilidae (gnatcatchers, gnatwrens; order Passeriformes) Family of small, active birds. Gnatcatchers are mainly grey and white, gnatwrens are mainly brown. They have long, slender bills, and long tails; inhabit scrub, often near water; feed on insects; and nest in trees. There are three genera, comprising 13 species, found in N., C., and S. America, and the W. Indies.

poliovirus Member of a group of viruses included within the family Picornaviridae. Human poliovirus is common in the human intestinal tract, usually without producing symptoms; however, under certain conditions it may invade the central nervous system, causing poliomyelitis.

polje Large, flat-floored depression bounded by steep valley walls and found in a karst environment. It is classically described for the Dinaric region of Yugoslavia, where it may result from faulting or from solutional processes controlled by a local base level.

Pollachius virens (saithe) *See* demersal fish.

pollard To behead a tree at a convenient height, usually about 2 m above ground level, in order to produce a crown of small poles, suitable for firewood, fencing, etc. This allows the production of small material out of the reach of deer and farm livestock.

pollarding System of wood management in which the main stem of a tree, usually a young one, is cut off about 2 m above ground level, thus favouring the development of lateral branches. With repeated pollarding a slightly swollen pollard boll develops in the main stem immediately beneath the lateral branches. Frequent pollarding, commonly seen in willows (*Salix* species), favours many relatively thin-stemmed lateral branches. Pollarding rather less frequently was the traditional management practice associated with wood-pastures, where grazing pressure made coppicing, the more usual method for generating new growth, impracticable. Wood-pastures were particularly characteristic of slower-growing upland woodlands, and woodlands on infertile soils. Pollarding was also used to encourage particular sizes and shapes of timber needed for structural purposes. In Britain, the Ancient and Ornamental Woodlands of the New Forest include classic relic wood-pastures with pollarded beeches and oaks.

pollen Collectively, the mass of microspores or pollen grains produced within the anthers of a flowering plant or the male cones of a gymnosperm.

pollen analysis *See* palynology.

pollen assemblage zone *See* pollen zone.

pollen beetle *See* Nitidulidae.

pollen diagram Standardized pictorial summary of the pollen record for a particular location. The vertical axis represents depth, and the proportions or absolute amounts of the various pollen types occurring at different levels are shown by bar histograms or by points on a continuous curve. Conventionally, similar patterns are grouped together on the diagram with arboreal types shown first followed in turn by shrubs, herbs, and spores.

pollen grain Microspore in flowering plants, which germinates to form the male gametophyte, a structure made up of the pollen grain plus a pollen tube. The grain contains three haploid nuclei (a tube nucleus and two sperm nuclei), which pass down the tube to the ovum. One of the sperm nuclei fertilizes the ovum, and the second fuses with the two polar nuclei forming the endosperm. The tube nucleus (which is considered to be vestigial, having been completely functional earlier in the evolution of flowering plants) degenerates after double fertilization—so called because of the two unions of nuclei.

pollen mother cell The microsporocyte which undergoes two meiotic divisions to produce four microspores (the first cells of the male gametophyte generation of seed plants). Each microspore becomes a pollen grain.

pollen rain Pollen grains and spores that fall on a particular site.

pollen tube Tube formed from a germinating pollen grain, and down which the two male gametes (sperm nuclei) pass to the ovum. In flowering plants each pollen tube penetrates tissues of stigma and style into the ovary where it grows towards an ovule, passing down the micropyle to the nucellus and finally penetrating into the embryo sac. Here the tip of the tube ruptures releasing the two male gametes: one of these fuses with the nucleus of the ovum; the other fuses with the two polar nuclei to give rise eventually to the endosperm.

pollen zone (pollen assemblage zone) Characteristic pollen-and-spore assemblage classically considered indicative of a particular type of climate, which was assumed to be typical of a fairly extensive geographic region. Changes from one group of pollens to another characteristic assemblage are used to define pollen-zone boundaries. The standard British (Godwin, 1940) and very similar European post-glacial (i.e. late Devensian and Flandrian) chronology recognizes eight major pollen zones: zones I–III being the characteristic late glacial sequence: older *Dryas* (I), Allerød (II), younger *Dryas* (III). More recently, based on N. American work, the importance of regional variation in the typical zone floras has been acknowledged, and a more flexible approach to pollen-zone definition applied. Pollen assemblage zones are defined in terms of their pollen and spore profiles alone for a particular site, and initially without reference to or matching with the standard zone models with their strong climatic links. This has enabled local changes, often man-induced rather than climatic, to be elucidated more clearly.

pollex The thumb. In the pentadactyl forelimb, it is the digit on the side of the radius, often shorter than the other digits.

pollination The transfer of pollen grains from the anther (part of the androecium) to the stigma (part of the gynoecium) of a flowering plant. This process facilitates contact between male gametes and the female ovum, leading to fertilization, development of seed and thence a new plant. In gymnosperms, the pollen tube containing a pollen grain grows down and penetrates the neck of the archegonium, facilitating contact between the sperm cells (male gametes) and the ova. Most archegonia contain many ova, so that multiple fertilization can occur, although only one sperm can fertilize an egg. Unlike angiosperms, which do not possess archegonia, pollen cones and seed cones mature at different times within a season, so that there is usually a long interval between pollination and fertilization.

pollinium A coherent mass of pollen grains, the product of a single anther lobe, transported as a single unit in pollination (as in the orchids).

pollutant Substance that enters the environment or becomes concentrated within it, and that has, or may have, a detrimental biological effect. Pollutants may occur naturally (e.g. sulphur dioxide and dust from volcanic eruptions), or be introduced by human activity (e.g. organochlorine pesticides such as DDT).

pollution The defiling of the natural environment by a pollutant. More loosely, environmental damage that is not caused directly by a physical substance, e.g. thermal pollution by waste heat, noise pollution by excessive noise, or vibration.

polyacrylamide gel Gel used to separate biological molecules, e.g. proteins of a given range of sizes. It is prepared by mixing a monomer (acrylamide) with a cross-linking agent (*N*,*N*′-methylenebisacrylamide) in the presence of a polymerizing agent, and leads to the formation of an insoluble three-dimensional network of monomer chains, which become hydrated in water. Gels of different pore sizes may be prepared depending upon the relative proportions of the above ingredients.

Polyalthia (family Annonaceae) Genus of trees and shrubs in which the crown is monopodial. The flowers are bisexual, with three sepals, and six petals which are often showy. There are a few to many fruits. There are 100 species, occurring in the Old World tropics, especially in SE Asia.

polyandry The mating of a female with more than one male at one time (usually taken to be during the course of a single breeding season). Simultaneous polyandry occurs where the female mates with more than one male to produce a clutch of eggs or brood of young bearing genes from each male. Successive polyandry occurs where the female mates with one male, lays eggs or gives birth to the young but plays little part in their parental care (usually cared for by this first male), instead moving off to mate with another male. The existence of the former situation is usually difficult to prove, and polyandry appears to be mainly of the latter type. Examples are a number of arctic species of wading birds, such as the Temminck's stint and grey phalarope. Polyandry is generally much rarer than polygyny, presumably because the mother is usually not sexually receptive following successful mating, and since she bears the young, she is more involved with their care and less able to seek another mate. Promiscuity is a form of polygyny or polyandry in which a member of one sex mates with more than one member of the other sex, but each relationship is an ephemeral one and terminates after mating, whereas in the other cases a bond of some kind forms.

polycentric (mycol.) Applied to a thallus that forms several or many reproductive centres.

polycentromic *See* spindle attachment.

Polychaeta (bristleworms; phylum Annelida) Class of annelid worms which possess distinct metameric segmentation. All have bristly parapodia on each body segment. Eyes may be present. Males and females occur. Most are marine, although some occur in fresh water and on land. The group first appeared in the Cambrian and it contains more than 5000 species.

polychore *See* wide distribution.

polychronic *See* polytopism.

Polycladida (class Turbellaria, subclass Archoophora) Order of platyhelminth worms which possess a pharynx. The larvae are free-swimming.

polyclimax theory *See* climax theory.

polycyclic (geomorph.) Applied to a landform or landscape that has been acted on by the erosional processes associated with two or more partially completed cycles of erosion. A diagnostic feature is an abrupt break of slope (*see* knick point) in the profiles of both rivers and hillslopes.

polyembryony The production of two or more individuals from a single egg by the division of the embryo at an early stage of development. Some parasitic wasps may produce hundreds of offspring from a single fertilized egg.

Polyergus rufescens (Amazon ant; order Hymenoptera, suborder Apocrita, family Formicidae) Species of dulotic ant parasitic on the ant *Formica fusca*. The workers have sickle-shaped mandibles with which they pierce the heads of *F. fusca* workers defending their brood. They occur in northern temperate regions. *See also* dulosis.

polyethism Functional specialization in different members of a colony of social insects, which leads to a division of labour within the colony. The various functions may be carried out by individuals of different morphology (caste polyethism) or of different ages (age polyethism).

polygamy In animals, a pattern of mating in which an individual has more than one sexual partner. *See also* polyandry; and polygyny.

polygene One of a group of genes that together control a quantitative character such as height or weight. Individually each gene has very little effect

on the resulting phenotype which instead requires the interaction of many genes. Before genes had been described, a multifactorial hypothesis had been constructed to explain the absence of clear-cut segregation into readily recognizable classes that show typical Mendelian ratios, as occurs with quantitative characters. In this case a group of interacting factors corresponds to a group of interacting genes.

polygenetic *See* conglomerate.

polygenic *See* multifactorial.

polygenic character Quantitatively variable character (phenotype) which is dependent upon the interaction of a number of genes.

Polygonaceae (buckwheats, docks, rhubarb, sorrels) Family of herbs, with a few shrubs and trees, in which the leaves are simple, entire, and usually alternate. They have an unusual sheathing stipule known as the ochrea (or ocrea) at the leaf base. The flowers are bisexual, regular, and are usually held in a raceme if they are not solitary. They are white, green, or pinkish. The 3–6 sepals often form a membrane wing around the fruit. There are no petals, and 6–9 stamens. The ovary is superior, with 2–4 carpels which are united to produce a single locule with free styles. The fruit is a trigonous nut with a seed containing a copious endosperm. The seeds are often dispersed by wind with the aid of the calyx wing; other seeds are hooked. The family is closely related to the Plumbaginaceae and is separated into three groups based on the geographical zone in which they are distributed: (a) the tropical, half-hardy, climbing trees and shrubs; (b) the shrubby buckwheats of arid habitats in SE Europe, C. Asia, and N. America; and (c) the temperate species, including the edible species, e.g. *Rheum rhaponticum* (rhubarb) and *Fagopyrym esculentum* (common buckwheat), the ornamentals, e.g. *Meuhlenbeckia* species and *Erigonum* species, and the weeds, e.g. *Rumex* species (sorrels and docks). There are 30 genera, comprising 700 species, distributed throughout the world, but with a concentration in the northern temperate regions.

polygyny In animals, a pattern of mating in which a male has more than one female partner. *Compare* polyandry; *see also* polygamy.

polyhaline 1 Applied to a highly salt-tolerant species that is not usually found outside very saline environments, e.g. *Limonium vulgare* (common sea lavender). 2 The second most saline zone of a salt-marsh, according to the Venice system for the classification of brackish waters. *See* brackish.

polyhalite Mineral, specific gravity 2.8, hardness 2.5–3.0, and with the chemical composition $K_2Ca_2Mg(SO_4)_4.2H_2O$. It occurs in bedded evaporite deposits and is one of the last minerals to be precipitated from saline waters, due to its high solubility. It is distinguished by its pink colour and bitter taste. It is normally flesh-pink to brick-red, and translucent, and has a silky to resinous lustre. It crystallizes in the triclinic system. It usually occurs as fibrous or lamellar masses.

polyhedrosis Disease of insects caused by certain DNA-containing viruses. The larval stages of flies, butterflies, moths, and sawflies may be affected, and the disease is frequently fatal.

polylectic Applied to bee species which collect pollen from a wide range of flowering plants.

polymerase Enzyme that catalyses the replication and repair of nucleic acids.

polymictic Applied to lakes (e.g. in high altitudes in the tropics) whose waters are circulating virtually continuously. If periods of stagnation occur they are very short.

Polymixia nobilis (beardfish) *See* Polymixiidae.

Polymixiidae (beardfish; class Osteichthyes, subclass Actinopterygii, order Polymixiiformes). Small family of deep-water fish which have a deep body, a pair of long chin barbels, a few spines preceding the dorsal and anal fins, and a forked tail-fin. *Polymixia nobilis* (beardfish), 30 cm, is probably widely distributed and may occur worldwide in tropical seas at depths of more than 200 m. There are two species.

Polymixiiformes Order of bony fish including the family Polymixiidae and fossil relatives. *See* Paracanthopterygii.

polymorph *See* leucocyte.

polymorphic Occurring in several different forms.

polymorphism 1 In genetics, the existence of two or more forms that are genetically distinct from one another but contained within the same interbreeding population. The polymorphism may be transient or it may persist over many generations, when it is said to be balanced. Classical examples of polymorphisms are the presence or absence of banding in *Cepaea* snails, the number of spots on the wings of ladybirds, and eye colour in humans. All these are visible polymorphisms that can readily be seen in nature. Some polymorphisms, however, are cryptic and require biochemical techniques to identify phenotypic differences. Such techniques include gel electrophoresis of enzymes and other proteins, and the fragmentation of the DNA molecule by restriction enzymes (which allows the sequencing of nucleotides), both of which operate nearer to the level of the genotype. 2 In social insects, the presence of different castes within the same sex. *See also* polytypism.

Polynemidae (threadfin; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine, coastal fish which have an elongate body; large eyes; two separate dorsal fins; a forked tail; and, typically, pectoral fins that are divided into two sections, the foremost section consisting of a number of filamentous finrays. The threadfins are a commercially important group of fish, with some, e.g. *Eleutheronema tetradactylus* (N. Australian giant threadfin, or Cooktown salmon), 1.2 m, regarded as good sportfish. They are distributed worldwide in tropical and subtropical seas. There are about 35 species.

Polynesian floral region Good's (1974) Polynesian subkingdom within his Palaeotropical kingdom,

which contains a small, derived flora with only nine or ten endemic genera, scattered through the various islands. The affinities are with the Malaysian and Australian regime, and there is no distinct 'Polynesian' flora as such. The great majority of the floral elements have been derived from adjacent floras.

Polyodontidae (paddlefish; class Osteichthyes, subclass Actinopterygii, order Acipenseriformes) Small family of freshwater fish which have many fossil relatives. They are very elongate fish, with a long, paddle-shaped snout, probably used for feeding on minute organisms sifted from the water. The skin is naked apart from some ganoid scales near the tail. The American species *Polyodon spatula* (1.8 m) is found throughout the Mississippi system and is locally of some commercial importance. Its only relative, *Psephurus gladius*, occurs in the Chang (Yangtze) Jiang, China.

polyoestrus In female Mammalia, the condition in which more than one oestrous cycle occurs in a breeding season or in a year.

polyomavirus Member of a group (genus) of viruses in the Papovaviridae which are found in a range of animals in which they appear to cause no harmful effects; however, in laboratory animals they can induce the formation of tumours.

Polyopisthocotylea (Polypisthocotylea; phylum Platyhelminthes, class Monogenea) Order of parasitic, platyhelminth worms in which the mouth, pharynx, and intestine are present. They are blood suckers.

polyp The soft-bodied, sedentary form of cnidarians, consisting of a cylindrical trunk which is fixed at one end, with the mouth surrounded by tentacles at the other end.

polypeptide Linear polymer composed of 10 or more amino acids linked by peptide bonds.

Polyphagidae (class Insecta, order Blattodea) Cosmopolitan family of mostly small cockroaches in which the females are often wingless, while the males fly readily. Some species are burrowers in desert regions (sand cockroaches), and one very small species occurs in the nests of leaf-cutter ants.

polyphagous Applied to a phytophagous species which feeds on a wide variety of plants.

polyphyletism The occurrence in taxa of members that have descended via different ancestral lineages. True polyphyletism has traditionally been distinguished from errors of classification, especially at the higher taxonomic levels, where organisms, as a result of convergent or parallel evolution, have been placed wrongly in the same natural group; but modern phyletic taxonomists would hold that any taxon found to be polyphyletic is unnatural, and so an 'error', and must be disbanded.

Polypisthocotylea *See* Polyopisthocotylea.

Polyplacophora (Loricata, chitons, coat-of-mail shells; phylum Mollusca, class Amphineura) Subclass of Amphineura in which seven or eight dorsal plates are generally composed of calcium carbonate and are enclosed by a spiculate girdle. The plates articulate with one another and overlap to a varying extent. The anterior and posterior plates differ from the others, the anterior plate often being ribbed. The head is often reduced. It contains a central mouth with a radula. The gills, which may be numerous, lie in a groove between the ventral foot and the girdle. The anatomy is typically molluscan, and the primitive nervous system has ganglionic swellings. Polyplacophora are entirely marine, and first appeared in the Upper Cambrian.

polyploidy The condition in which an individual possesses one or more sets of homologous chromosomes in excess of the normal two sets found in diploid organisms. It is caused by the replication within a nucleus of complete chromosome sets without subsequent nuclear division. Examples are triploidy ($3n$), tetraploidy ($4n$), hexaploidy ($6n$), and octoploidy ($8n$).

Polypodiaceae Family of leptosporangiate ferns, in which the sori are mixed, superficial on the lower surface of fronds, and usually rounded. They have a cosmopolitan distribution. In the wider sense, some 170 genera and several thousand species were included, but in the present-day classification (Crabbe, J. A. and Jermy, A. C., *Fern Gaz. 11*, 1975) the family is restricted to 56 genera.

Polypodium (family Polypodiaceae) Genus of ferns with pinnatifid or one-pinnate fronds borne on creeping fleshy scaly rhizomes; the sori are naked and rounded. The sori vein ends on each side of the mid-rib of the pinnae, and leaf veins form loops with the free vein ends inside. There are some 50 species, with a cosmopolitan distribution.

Polyporaceae (order Aphyllophorales) Family of fungi in which the hymenium lines tubes that open to the exterior by pores. The fruit body may be crust-like, bracket-like, or hoof-shaped, and may be annual or perennial. There are many genera, found on wood, on the ground, etc. They are mainly saprotrophic, but some are parasitic. The family includes some important tree pathogens and agents of timber decay.

polypore Any fungus of the order Aphyllophorales in which the fruit body bears its hymenium in a layer of tubes.

Polyporus (family Polyporaceae) Genus of fungi in which the fruit body is stipitate, the stipe being central, eccentric, or lateral. The context is white or pale-coloured. The spores are smooth and elongated. They are found on wood. Some species are parasitic on trees, causing a white rot. *See also* dryad's saddle.

polyprotodont In Marsupialia, applied to the condition in which there are three or more pairs of incisors in each jaw.

Polypteridae (bichir; class Osteichthyes, subclass Brachiopterygii, order Polypteriformes) Small family of freshwater fish with an elongate body, the skin covered with ganoid scales, and, typically, a dorsal fin consisting of a series of separate finlets each with its own stiff ray. The pectoral fins consist

of a fleshy stalk bearing a fan-like fin. Bichirs can use the modified swimbladder as a lung. *Polypterus bichir* (Nile bichir), 70 cm, has about 15 dorsal finlets. It is a carnivorous fish often found along the weedy edges of lakes and rivers. In addition to the 11 extant species a number of fossil species are known. They occur in Africa.

Polypteriformes Order of bony fish including only the family Polypteridae. *See also* Branchiopterygii.

Polypterus bichir (Nile bichir) *See* Polypteridae; and Branchiopterygii.

polyribosome *See* ribosome.

polysaccharide Linear or branched polymer composed of 10 or more monosaccharides linked by glycosidic bonds.

Polysiphonia (family Rhodomelaceae, order Ceramiales) Genus of red seaweeds which grow either on stones or as epiphytes on other algae. *P. lanosa* is an obligate parasite which grows on *Ascophyllum*; the thallus is filamentous and branched.

polysome Group of ribosomes attached to a single strand of messenger-RNA. Apparently each ribosome is at a different stage in the synthesis of the same polypeptide chain. Accordingly, the number of ribosomes in the polysome varies with the length of the message to be transcribed.

Polystichum (family Aspleniaceae) Genus of leptosporangiate ferns with spine-toothed pinnules, and rounded, superficial sori with circular peltate indusia; the leaves are of leathery texture. There are some 225 species, of cosmopolitan distribution.

Polystictus Obsolete genus of fungi; species formerly included in this genus have now been transferred to other genera. (*P. versicolor* is now *Coriolus versicolor*; *P. perennis* is now *Coltricia perennis*.) The name is still used occasionally as a form-genus for any fungus which forms annual, leathery, bracket-shaped fruit bodies.

polytene Giant, cable-like chromosome, which consists of many identical chromosomes closely associated along their lengths. It is formed by repeated duplication without division. An example is the salivary-gland chromosome of larval dipteran insects.

polythetic Using several or all possible criteria or attributes as the basis for each subdivision of a sample population or for agglomeration of individuals or groups. *Compare* monothetic; *see also* divisive method; agglomerative method; and hierarchical classification method.

Polythoridae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies which frequent streams. With the Epallagidae, they are the only odonates in which the larvae have large abdominal gills as well as the three terminal (tracheal) gills. There are more than 60 described extant species found in the New World tropics.

polytopic evolution *See* polytopism.

polytopic species *See* polytopism.

polytopism (polytopic evolution) Type of monophyletism in which a new (polytopic) taxon arises in more than one place from conspecific parents. The chances of this happening simultaneously, except perhaps in the case of subspecies, in each instance are remote; polytopic species may therefore be regarded also as polychronic species.

Polytrichales (subclass Bryidae) Order of acrocarpous mosses which may in some species be quite large (e.g. up to 40 cm); the stems are tough, and show some internal differentiation. The leaves have characteristic longitudinal plates or lamellae on the upper surface along the nerve; the leaf bases often sheath the stem. Polytrichales species are found on the ground in woods, on heathland, etc.

Polytrichum (order Polytrichales) Genus of mosses in which the plants grow in patches resembling miniature forests; the shoots arise from an underground, rhizome-like stem. The leaves have a broad, sheathing basal portion which abruptly narrows into a lanceolate to linear-lanceolate blade with a very wide nerve. The calyptra is characteristically densely hairy and covers the capsule. A cosmopolitan genus, it is found on the ground in woods, moors, heaths, etc., and is calcifuge. *See also* hair moss.

polytypic Of a species: divided into subspecies; varying geographically.

polytypism The occurrence of phenotypic variations between populations or groups of a species that are geographically distinct. It is contrasted with polymorphism, which is variation within a population or group. A species with systematic geographical variation (subspecies or clines) is said to be polytypic.

Pomacanthidae *See* Chaetodontidae.

Pomacanthus imperator (emperor angelfish) *See* Chaetodontidae.

Pomacentridae (damselfish, anemonefish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of mostly marine fish which have a relatively short but deep body, a small mouth, a single nostril on each side of the head, and an incomplete lateral line. They are often very conspicuous because of the beautiful colour patterns they show. The family includes many well-known species, e.g. *Chromis chromis* (damselfish) and *Dascyllus aruanus* (banded humbug). There are about 230 species, found mainly in the Indo-Pacific region.

Pomadasyidae (javelinfish, grunt; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of marine, perch-like fish, which have large eyes, a truncated tail-fin, a long dorsal fin, and strong spines to the dorsal and pelvic fins. *Pomadasys hasta* (spotted javelin), 60 cm, is widely distributed throughout the Indo-Pacific, where it is rated as a valuable food fish. There are about 175 species, distributed worldwide.

Pomadasys hasta (spotted javelin) *See* Pomadasyidae.

Pomaderris (family Rhamnaceae) Genus of shrubs and trees with alternate or opposite, simple leaves

with stipules. The flowers are small and inconspicuous, regular, bisexual, and usually borne in cymes. There are four or five sepals. The petals are not always present, but if present they are small and incurved, often folding over the four or five stamens. The ovary is superior with two or three locules, and a simple style. The fruits are fleshy and the seeds are usually dispersed by mammals and birds which feed on the fruits. Several species are cultivated as ornamentals. There are 45 species, confined to Australia and New Zealand.

Pomatomidae (bluefish, tailor; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family, including only *Pomatomus saltator* (bluefish), 1.1 m, which is an elongate and streamlined marine fish with a large mouth, short first dorsal fin, and long-based second dorsal and anal fins. It is a voracious predator, living in large schools in offshore waters, although it may come close to shore when following schools of prey fish. A commercially important species, it is also highly rated as a sportfish. It is distributed worldwide in tropical waters.

pomegranate (*Punica granatum*) *See Punica*.

Pometia (family Sapindaceae) Genus of trees in which the leaves are pinnate. The fruit is a leathery capsule with a few large, arillate seeds. The trees yield valuable timber. There are up to 10 variable species, occurring from Indo-Malaysia to Melanesia.

pompano (*Peprilus simillimus*) *See* Stromateidae.

Pompilidae (caterpillar-hunting wasps, spider-hunting wasps; suborder Apocrita, superfamily Pompiloidea) Family of large wasps (most 10–25 mm, but some up to 40 mm long) whose members provision their young with caught and paralysed spiders. They are long-legged, rarely fly, and run over the ground to catch their prey. Adults are usually dark-coloured, with dark wings which are not folded longitudinally at rest. They are distinguished from all other fossorial wasps by their well-developed hind-wing venation, and prothoracic structures. Nests are cup-shaped mud structures in crevices of rocks or trees, and some may be subterranean. The host may be left in its own burrow. Some species construct the nest first, then provision it with a paralysed spider; others catch their prey before building the nest. A few pompilid species lay their own eggs on the paralysed host of another species before it is interred in the nest. *See* hunting wasp.

pond skater *See* Gerridae.

pondweeds *See Potamogetonaceae*.

ponente Regional term for a westerly wind that blows in the Mediterranean.

Ponerinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of ants, which have one petiolar node and a sting. Polymorphism is often weakly developed, the workers resembling the queen. Most are predators and scavengers. There are about 2000 species: the majority occur in the tropics, and nest in soil or rotten wood.

Pongidae (order Primates, suborder Haplorhini, superfamily Hominoidea) The family of living and ancestral great apes, comprising the gorilla (*Gorilla gorilla*) and chimpanzee (*Pan troglodytes*) of Africa and the orang-utan (*Pongo pygmaeus*) and gibbons (*Hylobates*) of Asia, although most modern classifications allocate the gibbons to a separate family, the Hylobatidae, and many authorities prefer to include at least the African apes in the family Hominidae, together with humans. All members of the family are capable of a semi-bipedal gait. The thumb and great toe tend to be opposable, the thumb at least being reduced. There is no tail. Ischial callosities are small (gibbons) or absent (great apes). The nostrils are catarrhine and there are no cheek pouches.

Pongo pygmaeus (orang-utan) *See* Pongidae.

pons varoli In the vertebrate brain, a transverse mass of nerve fibres connecting the two parts of the cerebellum ventrally, located in front of the medulla.

Pontederiaceae (order Liliales) Family of monocotyledonous freshwater aquatic plants. The leaves have sheathing bases, often petiolate. The flowers are blue, lilac, yellow or white, with six perianth segments, often borne in a showy inflorescence enclosed by a spathe-like sheath. The fruit is a capsule or nutlet. The free-floating water hyacinth (*Eichhornia crassipes*) is probably the world's most serious aquatic weed. Other species are grown as aquatic ornamentals. There are nine genera, comprising about 34 species, occurring in the tropics and subtropics.

pony-fish *See* Leiognathidae.

poor man's weather glass *See* sea-belt.

Pope's buttons *See Bulgaria*.

poplar 1 *See Populus*. 2 (native poplar, *Codonocarpus cotonifolius*) *See Codonocarpus*.

poppy *See* Papaveraceae.

population dynamics The study of factors that influence the size, form, and fluctuations of individual species or genus populations. Emphasis is placed on change, energy flow, and nutrient cycling, with particular reference to homoeostatic controls. Key factors for study are those influencing natality, mortality, immigration, and emigration.

population ecology (autecology) The study of the interaction of a particular species or genus population (or sometimes of a higher taxon) with its environment.

population eruption *See* population explosion.

population explosion (population eruption) Sudden rapid increase in size of the population of a species or genus. The most violent explosions occur when a species is introduced into a new locality where it finds unexploited resources of suitable food, shelter, etc., and a lack of negative controls such as predators or parasites. Examples include the population explosions of the rabbit and prickly

pear when these were first introduced into Australia. The situation may be stabilized by the introduction of controls, e.g. the use of myxomatosis to control rabbit numbers. Alternatively, once food supplies become exhausted the population may crash, and even become locally extinct once more.

population genetics The study of inherited variation in populations of organisms, and its modulation in time and space. Population genetics relates the heritable changes in populations to the underlying individual processes of inheritance and development. Such studies generally involve the estimation of gene frequencies and the influences of selection, mutation, and migration upon these frequencies in natural (and experimental) populations.

Populus (aspens, cottonwoods, poplars; family Salicaceae) Genus of deciduous, dioecious, catkin-bearing trees, that differs from *Salix* in having many stamens in each male flower, toothed catkin scales, flowers with cup-like discs, and several outer scales to each bud. *Populus tremula* is aspen. There are some 30 species, found mostly in the northern temperate zone.

porcelain fungus *See Oudemansiella*.

Porcellionidae (woodlice; subclass Malacostraca, order Isopoda) Family of terrestrial isopods, including the cosmopolitan species *Porcellio scaber*, in which the flagellum of the second antennae is two-segmented. Tracheal lungs are present on the borders of the pleopods.

Porcellio scaber (common woodlouse; order Isopoda, family Porcellionidae) Species of woodlouse which can grow up to 18 mm long. It is nocturnal, being active for only about one hour before returning to its hiding place. It is the commonest and most widely distributed European woodlouse, occurring in gardens, greenhouses, and among rocky debris. Its distribution is cosmopolitan, accidental introduction by humans having been a major factor in its colonization of new areas.

porcupine 1 (Old World) *See* Hystricidae. 2 (New World) *See* Erethizontidae.

porcupine fish *See* Diodontidae.

pore (pedol.) A void surrounded completely by soil materials and created by the packing of mineral and organic particles. Pores can be filled by any proportion of air or water.

Porella (order Jungermanniales) Genus of leafy liverworts, including *P. platyphylla*, which is a robust, conspicuous species which can form fairly extensive patches. The stems are two- or three-pinnately branched and up to 8 cm long. The leaves overlap closely in the incubous arrangement. There are two lateral rows of leaves; each leaf is divided into two parts: a broad, ovate part, and a much smaller, narrower lobe which looks like a separate leaf. There is also a conspicuous row of leaves on the under-surface, so that when the plant is viewed from below it appears to have five ranks of leaves. The underleaves are broad and rounded with narrowly recurved margins. It is found, often abundantly, on shaded banks, tree roots, etc., mainly in calcareous districts.

pore space The total continuous and interconnecting void space in the bulk volume of soil.

porgy *See* Sparidae.

Poria (family Polyporaceae) Genus of fungi in which the fruit bodies are resupinate and non-stipitate, bearing tubes lined with hymenium; the context is white or pale-coloured. The spores are colourless, ovoid and truncate. *Poria* is found on wood.

Porifera (Spongiaria, sponges) Phylum of aquatic Metazoa, most of which are marine. They lack definite tissues and organs, but have a filter-feeding system composed of flagellate cells, pores, and canals. Most are covered externally by a cortex or dermis. The soft body is supported by a skeleton composed of siliceous or calcareous spicules, and some forms may possess organic fibres as well. Larvae are motile and produced by sexual reproduction. The phylum ranges from the Cambrian to Recent.

porosity The proportion, as the percentage volume, of the total bulk volume of a body of rock or soil occupied by pore space.

porphin The parent compound of the porphyrins: it consists of four pyrrole-like rings, linked into a ring system by four CH groups.

Porphyridiales (class Rhodophyceae) Order of algae which either are single-celled, or consist of rows of cells held together by a thick mucilage. *Porphyridium* is a common unicellular soil alga, forming blood-red mucilaginous layers in the soil surface and on rocks and walls.

porphyrin Heterocyclic derivative of a porphin, which is composed of a tetrapyrolle ring structure. As such it is capable of combining with a variety of metals and so forms part of the structure of many important biological molecules, including haemoproteins, chlorophyll, vitamin B_{12}, and cytochromes.

porphyritic *See* phenocryst.

porphyry An igneous rock with phenocrysts constituting more than 25% of the volume.

porpoise (*Phocoena phocoena*) *See* Phocoenidae.

porrect *See* Tortricidae.

Port Jackson shark (*Heterodontus portusjacksoni*) *See* Heterodontidae.

Portlandian The youngest stage of the Jurassic in Europe overlain by sediments of the Cretaceous Berriasian Stage and resting in turn on those of the Kimmeridgian. It is characterized in S. England by mollusc-rich limestones.

Portuguese man-of-war (*Physalia physalis*) *See* Nomeidae; and Rhizophysaliina.

Portulacaceae Family of herbs, close to Caryophyllaceae but with only two sepals and with petals often joined at the base. There are 17 genera, comprising about 200 species, in temperate and tropical regions, but centred in America.

Portunidae (swimming crabs; subclass Malacostraca, order Decapoda) Family of crustaceans in which the body is round, transversely oval, or square, with the anterior of the carapace not being narrowed. The fifth pair of legs is modified for swimming, being shaped as broad, flattened paddles which move in a figure-of-eight pattern. Some species use the modified legs for digging. The portunids are the most powerful and agile swimmers of all crustaceans and can swim forward, backward, and sideways with great rapidity. Males attend the females before the moulting period and carry them around beneath the body. The male releases the female to allow her to moult, and copulates with her soon after.

Porzana (crakes, rails; family Rallidae) Genus of small to medium-sized rails which have chestnut, brown, grey, and black plumage, many with barred under-parts. Their bills are short, and usually yellow or red. They are secretive and terrestrial, found in dense, often aquatic undergrowth, feed on animal and vegetable matter, and nest on the ground. There are about 15 species, found worldwide. Some island populations are endangered, and a number have become extinct.

possum *See* Phalangeridae.

postantennal organ More correctly known as the postantennal organ of Tömösvary, a pseudocellus found on the heads of Collembola. These organs may vary in structure from being a simple ring to a multituberculate sensory area.

post-climax In the mono-climax model of climax vegetation development, the term given to communities differing from the climatic climax due to cooler and/or moister conditions than are characteristic of the regional climate. Such conditions occur typically at higher elevations, especially on the windward slopes of mountain ranges. *See also* climax theory; *compare* pre-climax.

post-glacial *See* Flandrian; and Holocene.

postlarva 1 Stage in the development of a bony fish between the resorption of the yolk sac and the appearance of juvenile characteristics. 2 The larval stage following the nauplius stage in Crustacea, and the one in which the full complement of trunk segments and appendages appears for the first time. The postlarvae of many crustacean groups are sufficiently distinct to have been given special names, e.g. megalops (crabs), and acanthosoma (sergestid prawns).

post-medieval woodland Woodland that is known to have originated on a site that was not wooded prior to about 1650.

postorbital bar In the skull of vertebrates, the bar of bone which forms the posterior margin of the orbit.

post-partum (post-parturient) Applied to the period immediately following the birth of a mammal, but applied only to the mother.

postzygapophysis In a vertebra, the posterior facet that articulates with the prezygapophysis of the next vertebra behind.

potamodromous Applied to fish that undertake regular migrations in large freshwater systems.

Potamogeton (family Potamogetonaceae) Genus of water plants with creeping, sympodial rhizomes and erect, leafy branches, chiefly confined to fresh water. The leaves are alternate, simple or entire, and either all submerged or with some floating. Those with floating leaves tend to have broader leaves while those with all the leaves submerged tend to have narrow leaves. This is believed to form a series in evolutionary terms from land-based to truly aquatic plants. The flowers are axillary or terminal spikes, and are inconspicuous. The parts are in fours. The fruit is a small, green to brown drupe or achene containing seeds. These seeds have no endosperm but contain air, allowing the fruit to float. The plants overwinter as the complete plant, or die back to the rhizome, or form special branches with tubers or winter buds. There are about 100 species, found throughout the world in a variety of aquatic habitats. Most species are edible, and provide food for many animals.

Potamogetonaceae (pondweeds) Cosmopolitan family of aquatic herbs, found mostly in fresh water, that have submerged and translucent or sometimes leathery and floating leaves. The leaves may be narrow and linear, or elliptical. The inconspicuous flowers are borne in axillary or terminal spikes; are pollinated by water or wind; and have four sepals, four stamens, and four free carpels, each producing a fruit that is a nutlet. The family contains two genera, *Potamogeton* (about 90 species) and *Groenlandia* (one species).

Potamotrygonidae (river stingray; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Small family of freshwater stingrays in which the body has an almost circular profile ending in a fairly solid tail bearing a poisonous spine much feared by fishermen. *Potamotrygon motoro* (30 cm) is typical. These rays can be found partially buried in the mud of the river-bottom. There are about 10 species, in S. America, W. Africa, and SE Asia.

potassium (K) Element, required for healthy plant growth. Potassium ions neutralize anionic macromolecules and organic acids and thus control the water potential of cells. They pass readily through membranes and are important in the movements of leaves and guard cells. Deficiency leads to reduced growth and to dark or blue-green coloration in the leaves, which may also develop a purple-brown pigment.

potassium–argon method (K–Ar method) Geological dating technique based on the radioactive decay of potassium (^{40}K) to argon (^{40}Ar). This potassium isotope has a half-life of 1.3 billion (10^9) years, making this a valuable dating method for long time-scales. The minimum age limit for this dating method is about 250 000 years.

potato (*Solanum tuberosum*) *See Solanum*.

potato blight Late blight or early blight. Early blight is much the less serious of the two and is caused by the fungus *Alternaria solani*; dark, concentrically-zoned spots appear on the leaves of

infected plants. Both early and late blights can also attack tomato plants. *See also* late blight of potato.

potato scab Common scab or powdery scab. In common scab, caused by *Streptomyces scabies*, the scabs on the tubers are corky and superficial; the disease is commonest on light soils and in dry conditions. Powdery scab is caused by *Spongospora subterranea*, and is most common on heavy soils and in wet seasons; the scabs differ from those of common scab in that they are powdery.

potential instability (convective instability) Atmospheric condition in which otherwise stable air would become unstable if forced to rise, e.g. over high ground, thereby reaching its saturation point. Large cumulus with much precipitation often results from the forced uplifting of such air. *See also* instability; and stability.

potential-natural *See* natural.

pothole 1 Small, circular pit in the rocky floor of a river channel, produced by the abrasive action of coarse bedload material carried in a local swirl or eddy. 2 Nearly circular pipe found at the intersection of vertical joints in a karst region. It is due to carbonation at a location of enhanced drainage.

potoos *See* Caprimulgiformes.

potter wasps *See* Eumenidae.

Pottiales (subclass Bryidae) Order of acrocarpous mosses which are usually small; the leaves may be pointed or rounded, and have a nerve which may extend beyond the tip of the leaf in a 'hair point'. There is one family. Genera include *Barbula*, *Pottia*, and *Tortula*. They are found in a range of habitats: on walls, on the ground, on tree bark, etc.

potto (*Perodictus potto*) *See* Lorisidae.

pottoos *See* Nyctibiidae.

powder-post beetle *See* Lyctidae.

powdery mildew Either a fungus of the family Erysiphaceae or a plant disease caused by such a fungus. The leaves, fruit, etc. of an infected plant bear characteristic powdery white patches of conidium-bearing mycelium; tiny black perithecia may also be visible. Many types of plant may be affected, usually each by its own particular species or strain of fungus.

poxvirus (Poxviridae) Member of a group (family) of viruses in which the genome consists of double-stranded DNA. The virions are typically large and brick-shaped. They can infect a wide range of hosts, from insects to mammals, and the group includes some important disease-causing organisms.

PPI *See* plan-position indicator.

PPLO Pleuropneumonia-like organisms. *See* Mollicutes.

Praecardioida (phylum Mollusca, class Pelecypoda) Extinct order of thin-shelled pelecypods which were elongate, circular, or oval in shape. They were isomyarian, and had an opisthodetic or amphidetic external ligament. The hinge plate was poorly developed or absent; the hinge margin consisted of interlocking, taxodont teeth, or was edentulous. Some had gaping terminal margins, most had an entire pallial line, but some had a small pallial sinus. They first appeared in the Lower Ordovician, and died out in the Lower Carboniferous.

praecipitatio From the Latin *praecipitatio* meaning 'I fall', a supplementary cloud feature in which precipitation from the cloud base falls to the ground. The feature is usually seen with cumulus, cumulonimbus, stratus, stratocumulus, nimbostratus, and altostratus. *See also* cloud classification.

praemorse (premorse) Having the end terminated abruptly.

prairie Temperate grassland of N. America, dominated by more or less xeromorphic grasses, which fall into three groups based on stature—'tall', 'mid', and 'short'—with a progressive decrease in rainfall. Various herbaceous broad-leaved annuals and perennials are mixed in with the grasses.

prairie dog (*Cynomis*) *See* Sciuridae.

pratincoles *See* Glareolidae.

praying mantis *See Mantis religiosa*; and Mantodea.

pre-adaptation Adaptation evolved in one adaptive zone which, quite by chance, proves especially advantageous in an adjacent zone and so allows the organism to radiate into it. No selection for a future environment is implied.

pre-Boreal The first Flandrian (Holocene, or post-glacial) stage, a time of rapid forest spread, from about 10 300 to 9600 BP. 'Pre-Boreal' refers to climatic conditions and in vegetational terms is equivalent to Pollen Zone IV of the standard British and European post-glacial pollen chronology.

Precambrian The longest period of geological time, which began with the consolidation of the Earth's crust and ended with the beginning of the Cambrian Period 570 million years ago. The Precambrian lasted approximately 4000 million years; the rocks of this period of geological time are usually altered and few fossils with hard parts or skeletons have been found within them. Precambrian rocks outcrop extensively in shield areas such as northern Canada and the Baltic Sea. In many texts the Precambrian is subdivided into the Archaean and Proterozoic.

precious coral (*Corallicum*) *See* Scleraxonia.

precipitable water The quantity of rainfall that would result from condensation and precipitation of the total moisture in a column of air in the atmosphere. Most atmospheric moisture is contained in the lower atmosphere, below about 5500 m. On average, an atmospheric column of 1 m^2 cross-section contains vapour equivalent to 5–25 mm depth of rainfall. The average residence time of moisture in the atmosphere is about nine days.

precipitation 1 In meteorology, usually means all the forms in which water (H_2O)—as rain, sleet, snow, hail, drizzle, or other more specialized

forms—falls to the ground, and the amounts measured. Sometimes precipitation seen falling from clouds evaporates before reaching the ground. 2 The process of depositing dust or other substances (pollution) from the air.

precipitation-efficiency index Devised in 1931 by C. W. Thornthwaite, an index based on the ratio of mean monthly rainfall and temperature values in relation to evaporation rates. Summation of monthly values gives an annual precipitation-efficiency index (P/E), which is used to define major climatic regions. *See also* Thornthwaite climate classification.

pre-climax In the mono-climax model of climax vegetation development, the term given to communities differing from the climatic climax due to hotter and/or drier environmental conditions than are characteristic of the regional climate. Such conditions typically occur in rain-shadow areas in the lee of mountain ranges. *See also* climax theory; *compare* post-climax.

precoracoid Bone of the pectoral girdle, present as an element of the coracoid in some amphibians and as a separate bone in many reptiles and some Monotremata, but which is vestigial or absent as a distinct entity in most other mammals.

predation Interaction between species populations in which one organism, the predator, obtains energy (as food) by consuming, usually killing, another, the prey. Most typically, a predator is an animal that catches, kills, and eats its prey; but predation also includes feeding by insectivorous plants and grazing interactions, e.g. the complete consumption of unicellular phytoplankton by zooplankton. Predation is analogous to parasitism in being both a means of feeding and a cause of immediate harm, but differs in that predators are usually larger than prey organisms and the prey is usually wholly consumed. The distinction is not clear-cut, especially for insect populations. In detail, a continuous gradation of interactions is found from predation to parasitism.

predation analysis The mathematical modelling of predator–prey relationships as, for example, in the Lotka–Volterra equations. Using these models, computer simulations of predator and prey behaviour can be made and tested against field results. This gives a useful insight into the development of community structure, and more particularly into the behaviour of pest organisms and other species that are important commercially or in conservation.

predator *See* predation.

preen gland *See* preening.

preening Grooming behaviour performed by birds for the maintenance of feathers. Preening cleans feathers, but also oils them with a substance secreted by a preen gland near the tail: the bird applies this substance with the tip of its bill. The oil renders the feathers supple and water-resistant, and ingested oil supplies the bird with some vitamin D.

preferential species In phytosociology, a species that is present with varying abundance in several communities, but is especially abundant and vigorous in one particular community. It belongs to fidelity class 3 in the Braun-Blanquet phytosociological scheme. *Compare* accidental species; exclusive species; indifferent species; and selective species.

preformation *See* epigenesis.

prehensile Capable of grasping.

premaxilla Bone forming the anterior part of the upper jaw. In mammals it bears the incisors; in birds it forms much of the upper bill.

premolar In mammals, one of the deciduous cheek teeth located between the canines and the molars.

premorse *See* praemorse.

pre-oral Relating to the region in front of the mouth.

Presbytis entellus (entellus langur) *See* Cercopithecidae.

Pressler borer *See* increment borer.

pressure-gradient force (PGF) The force acting on air due to pressure differences. Horizontal variations in pressure create a tendency for movement from higher to lower pressure: this is only one component of the forces acting on the actual wind, though, so air does not normally flow at right angles across the isobars. Other forces are associated with the rotation of the Earth underneath the moving wind and a centrifugal force where the path of the wind is curved. In practice the air moves nearly along the isobars above the friction layer. *See also* Coriolis force; and geostrophic wind.

pressure solution The process that occurs preferentially at the contact surface of grains or crystals as a result of an excess of external pressure relative to the hydraulic pressure of pore fluids. Material in these zones is dissolved and removed, resulting in an increase in compaction and a decrease in porosity.

pretarsus *See* Araneae.

prevailing climax The most common undisturbed, stable community that occurs in a region. In any given area various stable communities are found in response to local differences in habitat. Gradual transitions from one stable type to another occur as environmental controls change. The steady-state community occupying the largest number of non-extreme habitats in the area is the prevailing climax. This approximates to the climatic climax communities for the area. Unlike mono-climax, prevailing climax does not involve consideration of possible long-term climatic changes, or associated habitat changes due to weathering and erosion. Thus it is a more practicable and readily applied concept. *See also* climax theory.

prevailing wind In a particular locality, the wind direction that is most frequent over time. For most areas the prevailing wind varies, sometimes quite markedly, according to season. It may also change, or have changed, when the climate changes (as in ice ages).

prevernal In the early spring. The term is used with reference to the six-part division of the year used by ecologists, especially in relation to studies of terrestrial and freshwater communities. *Compare* aestival; autumnal; hibernal; serotinal; and vernal.

prey *See* predation.

prezygapophysis *See* postzygapophysis.

Priacanthidae (big-eye, bullseye; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of deep-bodied marine fish which have very large eyes, an oblique mouth, and heavily spined fins. Like *Priacanthus arenatus* (Atlantic big-eye), 40 cm, they tend to have a red colour and to become active at night. There are about 18 species, distributed worldwide.

Priacanthus arenatus *See* Priacanthidae.

Priapulida Phylum comprising the priapus worms, known from Cambrian times, up to the present.

priapum fish *See* Phallostethidae.

pride of India (*Melia azedarach*) *See Melia*.

prickleback *See* Stichaeidae.

pricklefish *See* Stephanoberycidae.

primary One of the outer flight feathers of birds, which originate from the hand or manus. Most non-passerines have ten primaries. Ciconiidae (storks), Phoenicopteridae (flamingos), and Podicipedidae (grebes) have 12; Ardeidae (herons), Anatidae (ducks, geese, etc.), and some other groups have 11. Most passerines have nine functional primaries, the tenth being reduced.

primary productivity (primary production) The rate at which energy is stored by photosynthetic and chemosynthetic autotrophs (mainly green plants) in the form of organic substances that may be used as food materials. Gross primary productivity (GPP) is the total rate of photosynthesis and chemosynthesis, including that portion of the organic material produced that is used in respiration during the measurement period. Net primary productivity (NPP) is the rate of production of surplus organic material after some has been lost to plant respiration during the measurement period. Net community productivity is the rate of accumulation of organic material, allowing for both plant respiration and heterotrophic predation during the measurement period. Rates of storage at higher trophic levels are termed secondary productivities. Strictly, the primary production of an ecosystem (as distinct from its productivity) is the amount of organic material accumulated. It is usual to indicate a period of time, however, since otherwise such data have limited value. Thus in practice the terms 'production' and 'productivity' are often used interchangeably. It is also vital to indicate whether production figures relate to net primary or net community productivity, or to some portion of these, as with a harvested crop.

primary sexual character Organ that produces gametes. Examples are the testes of male and the ovaries of female animals; and the male anther and female carpel of flowering plants.

primary structure The basic structure of a polypeptide chain. It relates solely to the type, number, and sequence of amino acids or nucleotides in the chain. *Compare* secondary structure; tertiary structure; and quaternary structure.

primary succession (prisere) Succession initiated on a newly-produced bare area, e.g. following glaciation or major earth movements. Since no living remnants of a previously existing community are present successional stages and plant–physical environment interactions are usually fairly clear, at least initially. *Compare* secondary succession.

primary woodland Woodland occupying a site that has been continuously wooded (in Britain since the last ice advance) even though it may have been clear-felled, provided that the clear-felling does not break the woodland continuity (i.e. the woodland regenerated or was replanted).

primary woodland species 1 Tree species that are confined to primary woodland. 2 Tree species that occur in primary woodland but also in localities where their presence is explained by planting or by their survival from the clearance of what was once primary woodland, e.g. on hedges and stream banks.

Primates (subclass Theria, infraclass Eutheria, cohort Unguiculata) Order of mammals which have adapted to arboreal life and in some forms secondarily to life on the ground. Perhaps arising from this adaptation, eyes and ears are well developed, with binocular vision in many forms; the sense of smell is less developed, the snout commonly being reduced. The braincase is large, the olfactory region often being reduced. The neck is very mobile; shoulders and hips permit large limb movement; and the limbs are wholly free from the body wall. The clavicle is strong; the scapula can be rotated; the radius and ulna are separate and jointed; the tibia and fibula are separate except in Tarsiiformes. Digits are often long, with sensitive pads at their tips and in most forms flat nails rather than claws. The hallux is always opposable, the pollex often so. The teeth are unspecialized; the diet usually omnivorous. In monkeys, apes, and humans the uterus is single and the foetal and maternal bloodstreams are separated only by the walls of the foetal vessels. Usually there is a single pectoral pair of mammae. The number of young produced is small and parental care continues long after birth. The Primates are divided into two suborders, Prosimii and Anthropoidea, or Strepsirhini and Haplorhini, but the (extinct) Plesiadapiformes are nowadays commonly regarded as a third. The Primates diverged from shrew-like ancestors in the Cretaceous. The most primitive living members of the order, the prosimians (lemurs, lorises, and tarsiers), arose in the Eocene, and monkeys and apes had appeared by the Oligocene. The time at which the hominid line diverged from that of the African apes (gorilla and chimpanzee) is controversial: times of as much as 20 million and as little as 4.5 million years ago are suggested.

primitive (evol.) Preserving the character states of an ancestral stage. The term may be used of a

character (as a synonym of 'plesiomorph') or, occasionally, of a whole organism.

primordium The early cells that serve as the precursors of an organ to which they later give rise by mitosis during development.

Primulaceae Cosmopolitan family of herbs, with a few low shrubs, in which there are no stipules to the leaves. The flowers are regular, mostly with parts in fives, but sometimes up to nines. The corolla is wheel-, bell-, or funnel-shaped; the petals are usually joined into a tube below; the stamens are attached to the corolla and lie opposite its lobes; the ovary is usually superior and one-celled, with a free central placenta; and the style is undivided. The family includes many attractive genera, e.g. *Primula*, *Cyclamen*, and *Lysimachia*. Modern classifications recognize about 30 genera with 550 species, found mainly in northern temperate regions.

Primula vulgaris *See* heterostyly.

princess palm (*Dictyosperma album*) *See Dictyosperma*.

Prinia (prinias; family Sylviidae) Genus of small, mainly brown warblers, many of which are streaked, with long tails, and most of which have only 10 tail feathers. They inhabit dense scrub, feed on insects, and build woven nests in bushes and weeds. There are about 25 species, found in Africa and Asia.

Prionace glauca (blue shark) *See* Carcharhinidae; and nictitating membrane.

Prionopidae *See* Laniidae.

prions *See Pachyptila*; and Procellariidae.

prisere *See* primary succession.

prismatic *See* texture.

Pristidae (sawfish; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Small family of marine fish. Because of their elongate bodies, sawfish tend to resemble sharks, but the gill clefts are in a ventral position, as in other rays. Typically, members of the family have a long, flat snout with blunt and equal-sized teeth along the edges. They are common in all tropical seas and estuaries, where they may be a nuisance to fishermen. *Pristis zijsron* (green sawfish) of the Indo-Pacific is known to grow to at least 7 m long. There are about six species, distributed worldwide.

Pristiophoridae (sawshark; class Chondrichthyes, subclass Elasmobranchii, order Squaliformes) Small family of sharks in which the long snout, or rostrum, is formed into a flat blade equipped with teeth of uneven size along the edges. Sawsharks differ from Pristidae (sawfish) in having the gill slits on the side of the body and in possessing a pair of barbels located half-way along the snout. *Pristiophorus cirratus* (common sawshark), 1.1 m, of E. Australia, and other species are quite edible. There are about four species, found in African and Indo-Pacific waters.

Pristiophorus cirratus (common sawshark) *See* Pristiophoridae.

Pristis zijsron (green sawfish) *See* Pristidae.

probable mutation effect The idea that, as most mutations act to produce failures of development, a non-essential organ will eventually be reduced simply by repeated mutations accumulating in a population. This idea has been used to explain the loss of hind limbs in whales, etc.

Proboscidea (subclass Theria, infraclass Eutheria, cohort Ferungulata, superorder Paenungulata) Order comprising the elephants and their extinct relatives, divided into four suborders: Moeritherioidea, Deinotherioidea, Gomphotherioidea, and Mammutoidea. The mastodons are included in the suborder Mammutoidea. The suborder Gomphotherioidea includes two families, Gomphotheriidae and Elephantidae, the mammoths, modern elephants, and their immediate ancestors being included in the latter. The order was formerly highly successful and occupied the Americas, Eurasia, and Africa. Probiscideans tend toward large size. Since the late Miocene most have possessed a long trunk: this is developed from the nose and upper lip, is operated by a complex musculature, is sensitive to chemical and tactile stimuli, and is used to obtain food and water and in making sounds (which are important in social organization). Teeth are reduced in number, adults having three molars in each side of each jaw; these are used one at a time, old teeth being shed and replaced by those behind. The upper incisors are enlarged to form tusks. The jaw muscles are large, and the skull short and high. The vertebrae and up to 20 ribs carry the weight of the abdomen, which is balanced on the forelimbs by the weight of the head, the hind limbs providing propulsion. The brain is well developed. Parental care of the young is prolonged, and social organization is complex.

proboscis monkey (*Nasalis larvatus*) *See* Cercopithecidae.

proboscis worms *See* Nemertini.

procaine A local anaesthetic.

procambium In a plant, the groups of elongated cells found at growing tips of roots and stems: they develop into vascular bundles as the plant continues to grow.

Procaryotae (kingdom Monera) Kingdom comprising mainly unicellular organisms in which the cells lack a true nucleus, and the DNA is present as a loop in the cytoplasm, rather than as chromosomes bounded by a nuclear membrane. They comprise the bacteria and cyanobacteria (blue-green algae). The former appeared in the fossil record more than 3000 million years ago, and so are the oldest known forms of life. The latter are known from slightly younger rocks. Together they constitute the kingdom Monera, from which all other organisms are descended.

Procaviidae (hyraxes) *See* Hyracoidea.

Procellariidae (fulmars, prions, petrels, shearwaters; order Procellariiformes) Family of medium to large, white, grey, brown, or black seabirds which have long, pointed wings, and short tails.

Their bills are short and heavy to long and slender, and have tubular nostrils, united on the top. Their legs are short to medium, their feet webbed. They are migratory, pelagic, and gregarious, and feed from the sea surface on fish, crustaceans, and fish offal. They nest in burrows and rock crevices on cliffs and islands. There are 12 genera, comprising about 60 species, found in all oceans.

Procellariiformes (albatrosses, diving petrels, petrels, shearwaters, storm petrels; class Aves) Order of small to large seabirds, with small to large bills which have horny plates and tubular nostrils. They secrete oil which can be regurgitated in defence and which gives them a musty smell. They are pelagic, marine birds, feeding on fish, plankton, crustaceans, and other invertebrates, and nesting on isolated islands and cliffs. There are four families, found worldwide.

procoelous Applied to vertebrae in which there is a concavity on the anterior surface.

Procolophonia Relatively advanced cotylosaurs (stem reptiles), distinguished from the lower types by their shorter jaws and better jaw movement. These anapsids lived in the Triassic and Permian.

Proctotrupidae (suborder Apocrita, superfamily Proctotrupoidea) Small family of moderately common, shiny black insects which have characteristic wing venation. The forewing has a costal cell with a large stigma (darkened area) and a very small marginal cell. The antennae are 13-segmented, and arise from the middle of the face. Adults are 3–12 mm long, and have spindle-shaped abdomens on short petioles. Little is known about the larval stages of some species, but some parasitize the larvae of Coleoptera.

procumbent Projecting forward, more or less horizontally, e.g. procumbent incisors.

procuticle *See* exoskeleton.

Procyonidae (raccoons; order Carnivora, suborder Fissipedia, superfamily Canoidea) Family that includes the raccoon, coati, and perhaps the pandas —relatively short-legged, mainly arboreal mammals in which the gait is plantigrade or semi-plantigrade; the claws are partly retractile or non-retractile; the canine teeth are long and rectangular in cross-section; the carnassials are developed only weakly; the auditory bulla is well rounded; and the paraoccipital process is prominent. The diet is omnivorous except in the case of the giant panda (*Ailuropoda melanoleuca*), which is herbivorous. The Procyonidae broke away from the main canid line in the early Oligocene and were present in both Europe and N. America at that time. Their fossil record in Asia begins in the Miocene. There is currently dispute as to whether the pandas (*Ailurus fulgens* (red panda) and *Ailuropoda*) should be referred to this family rather than the Ursidae, or to one or two separate families on their own. *Ailuropoda* is now more generally considered an ursid. If the pandas are included, there are eight genera, comprising about 19 species, found in N. and S. America and parts of Asia.

Procyon lotor (raccoon) *See* Procyonidae.

producer In an ecosystem, an organism that is able to manufacture food from simple inorganic substances, i.e. an autotroph. Most typically a green plant.

production *See* primary productivity.

production ecology The branch of ecology dealing with energy flow and nutrient cycling within ecosystems.

production/respiration ratio (P/R ratio) The relationship between gross production and total community respiration. Where P/R = 1 a steady-state community results. This balance may be an instantaneous daily one (e.g. in tropical rainforest communities), or over a longer period (e.g. in temperate woodlands). If P/R is persistently greater or less than 1 then organic matter either accumulates or is depleted respectively.

productivity *See* primary productivity.

Productus giganteus (*Giganto productus*) A huge brachiopod which attained a width of approximately 370 mm. It lived in the warm seas of the Lower Carboniferous (Mississippian), adopting a clam-like habit.

proenzyme *See* zymogen.

profile A vertical section through all the constituent horizons of soil, from the surface to the relatively unaltered parent material.

profundal zone The bottom- and deep-water area of freshwater ecosystems that lies beyond the depth of effective light penetration (*see* compensation level). In shallow freshwater systems, such as ponds, this zone may be missing.

Proganochelys quenstedii (*Triassochelys quenstedii*) The oldest known turtle, described by Bauer in 1887 from the Triassic Stubensandstein of Württemburg, Germany. It possessed teeth, and stout ribs on the neck vertebrae.

progesterone Steroid hormone secreted mainly by the corpus luteum. It is responsible for the maintenance of pregnancy.

proglacial lake Body of water impounded between a glacier and adjacent high ground. It is often inferred for areas of Pleistocene glaciation from the evidence of strandlines, lake sediments, and overflow channels.

proglottis (pl. proglottides) In Cestoda, one of the segments of which the animal consists.

progressive evolution Steady, long-term improvement of evolutionary grade, which has allowed plants and animals to become ever more independent of the aquatic environment in which they first evolved. For example, the sequence bryophyte, pteridophyte, gymnosperm, angiosperm represents a progressive evolutionary trend.

progressive feeding The provision of larval food by female wasps and bees at regular intervals throughout the period of larval growth. It is practised by all the social vespid wasps and the honeybees (*Apis* species). It is uncommon in solitary (non-social) species, though it is found in some sphecid and nyssonid wasps.

progressive succession The normal sequential development of communities, from simple communities with few species and low productivity to the optimum sustainable in a given environment. It is contrasted with retrogressive successional change (retrogression).

progressive wave A wave that is typified by the progressive forward motion of the wave form. $C = L / T$: the speed of a moving wave (C) can be calculated by dividing the wavelength (L) (the distance between two consecutive crests) by the wave period (T) (the time it takes two successive crests to pass a fixed point).

Progymnospermopsida The ancestors of the gymnosperms, which arose in the Devonian and dwindled to extinction in the latter part of the Carboniferous. Probably seeds evolved in various different progymnosperms.

pro-insulin The inactive precursor of insulin which becomes converted to the active form through the hydrolytic removal of a peptide composed of 33 amino acids.

prokaryote *See* Procaryotae.

prolactin (lactogenic hormone) Protein hormone, secreted by the adenohypophysis (anterior pituitary), that initiates lactation in mammals and stimulates the production of progesterone by the corpus luteum.

prolarva In fish, the stage of development between hatching and resorption of the yolk sac.

prolegs (false legs) Unjointed, fleshy protuberances found on the abdomen of certain insect larvae, in contrast with true legs, which are jointed and found on the thorax. In Lepidoptera, prolegs, which usually bear sclerotized hooks called 'crochets', are usually found on segments 3–6 and 10, but some or all may be absent.

prolicide The killing of offspring.

proline Heterocyclic, non-polar imino acid, present in all proteins studied to date.

Promeropidae (sugarbirds; order Passeriformes) Family of fairly large, brown birds which have long, decurved bills, and long, slender, elaborate tails. They inhabit mainly *Protea* bushes, feed on insects and nectar, and build an open cup nest in bushes. There is one genus, *Promeropus*, with two species, found in S. Africa.

Promicrops lanceolatus (Queensland grouper) *See* Serranidae.

promoter Nucleotide sequence within an operon, lying between the operator and the structural gene or genes, that serves as a recognition site and point of attachment for the RNA polymerase. It is the starting point for transcription of the structural gene or genes in the operon, but is not itself transcribed.

pronghorn (*Antilocapra americana*) *See* Antilocapridae.

pronotum The dorsal, sclerotized cuticle of the first thoracic segment of an insect. *See also* prothorax.

propagule Any structure that functions in propagation and dispersal, e.g. a spore or seed. *See also* migration.

propatagium The part of the patagium that lies to the anterior side of the forelimbs.

prophage The genome of a bacteriophage associated with a bacterium in the state of lysogeny.

Prophalanopsidae (Haglidae, hump-winged crickets; order Orthoptera, suborder Ensifera) Family of primitive ensiferans, which includes only three living species.

prophase The first phase of mitosis and meiosis, during which the chromosomes become visible within the nucleus, coiling up to produce a series of compact spirals. In meiosis they also undergo pairing during this phase, the phase then being divided into five successive stages: leptotene, zygotene, pachytene, diplotene, and diakinesis.

Propionibacteriaceae Family of Gram-positive bacteria in which the cells are variable in shape, forming branched or unbranched, regular or irregular rods or filaments. They are chemo-organotrophic; most strains grow only in the absence of air. There are two genera, found in dairy products, in soil, on skin, and in the respiratory and intestinal tracts of animals. Some species can cause disease.

proplastid Colourless, double-membrane-bound organelle, with little internal structure, that acts as a precursor in the development of all plastids.

propleurum (pl. propleura) The lateral, sclerotized cuticle of the first thoracic segment of an insect. *See also* metathorax.

propodeum The structure formed by the incorporation of the first abdominal segment with the thorax in members of the hymenopteran suborder Apocrita. The propodeum always has a pair of large spiracles, and there is almost always a constriction (of varying strength) between it and the rest of the abdomen.

propolis Resins of plant origin collected by honeybee (*Apis* species) workers and used to seal gaps in the nest or hive, or to reduce the nest entrance to a suitable size. Sometimes it is also used to entomb large trespassers into the nest (e.g. mice) which have been killed by workers acting as guard bees.

Prosauropoda Primitive, partly bipedal, saurischian dinosaurs, largely restricted to the Upper Triassic. They were heavily-built herbivores, and gave rise to the large sauropods of the Jurassic and Cretaceous.

Proscopiidae (order Orthoptera, suborder Caelifera) Family of extremely elongate, stick-like grasshoppers, which have conical heads. About 100 species are known, all endemic to S. America.

Prosimii (cohort Unguiculata, order Primates) In many classifications the primates are grouped into two suborders: Anthropoidea, which includes the Old and New World monkeys, apes, and humans; and the Prosimii, comprising the more primitive

lemurs, lorises, and tarsiers. Prosimii, therefore, is sometimes used for a suborder to include the four infra-orders: Plesiadapiformes, of extinct primates; Lemuriformes, of the lemurs and like forms; Lorisiformes, of the lorises and potto; and Tarsiiformes of the tarsiers. In modern classifications the tarsiers are included with the anthropoids in the suborder Haplorhini and the remaining living primates are then placed in the suborder Strepsirhini, the Plesiadapiformes being placed in a third suborder.

prosobranch gastropods Single-gilled gastropods, thought to represent the first stage in the evolutionary development of the group from the ancestral forms, the Archaeogastropoda.

prosoma *See* Arachnida.

Prosopora (phylum Annelida, class Oligochaeta) Order of exclusively aquatic annelid worms all of which have paired testes. Some members are ectoparasitic. There are two families.

Prosotheca (phylum Annelida, class Oligochaeta) Order of very small annelid worms, comprising one family, Enchytraeidae, which occur mainly on land or in fresh water, although some are marine. They are first recorded from the Tertiary.

prostaglandin One of a group of C_{20} fatty acids, each containing a five-membered ring. Prostaglandins differ from one another in the number and position of double bonds and hydroxyl-group constituents. Their biological effects include the lowering of blood pressure and the stimulation of smooth-muscle contraction.

Prostanthera (mintbushes; family Labiatae) Genus of shrubs which are usually glandular and yield aromatic oils. The leaves are opposite. The flowers are solitary and held in the axils of bracts, or are borne in terminal panicles or racemes. The calyx is two-lipped and persistent. The corolla is a short, wide tube with an erect upper lip which is often hooded and two-lobed, and a lower lip of three spreading lobes. There are four stamens. The style is simple, the stigma bilobed. The fruit is a nutlet. There are about 65 species, all endemic to Australia where the shrubs often occur in the understorey of *Eucalyptus* forests.

prosternum The ventral, sclerotized cuticle of the first thoracic segment of an insect. *See also* prothorax.

prostheca In certain types of bacteria, a stalk-like appendage that occurs as an extension of the cell.

prosthetic group Non-protein component of a conjugated protein, or the cofactor of an enzyme to which it is bound so tightly that it cannot be removed by dialysis.

Protacanthopterygii Superorder of bony fish, including the Salmoniformes.

protalus rampart Ridge of rock debris less than 10 m high and found near the base of a steep inland face. It consists of frost-shattered debris that has been carried some distance from the face across the steep surface of a basal snow bank.

protamine Generic term for a group of strongly basic, globular proteins of relatively low molecular weight, which contain large quantities of the amino acid arginine, but no sulphur. They are found associated with nucleic acids, particularly in sperm cells.

protandry (adj. protandrous) 1 In plants (e.g. dandelion), the maturation of anthers (i.e. male organs) before carpels (female organs). 2 In animals, the production of sperm in males before females produce eggs (e.g. some roundworms). 3 The arrival of males before females at breeding grounds (e.g. many territorial bird species). The reciprocal condition, in which female parts develop before those of males, or females arrive at breeding grounds in advance of males, is called protogyny.

Protanisoptera *See* Anisozygoptera.

Proteaceae One of the most prominent plant families in the southern hemisphere, comprising trees and shrubs in which the leaves are entire or divided, spiral, without stipules, leathery, and commonly xeromorphic. The flowers are usually held in showy, dense inflorescences; they are usually hermaphrodite and zygomorphic, with four tepals (often becoming recurved), four scales, four stamens (often epipetalous), and a superior, unilocular ovary, with one to many ovules. The fruits are various. There are 62 genera, comprising 1050 species, occurring in the southern hemisphere, and developed strongly in S. Africa and Australia.

protease Enzyme that catalyses the hydrolysis of the peptide bonds of proteins and peptides. There are two types: endopeptidases (proteinases) primarily attack interior peptide bonds, while exopeptidases act on those adjacent to a free amino or carboxyl group.

Proteidae (mudpuppies, olm; class Amphibia, order Urodela (Caudata)) Family of aquatic, permanently larval salamanders, which have an elongate body, small or rudimentary limbs, lidless eyes, and external gills retained even when lungs are present. There are two genera: *Proteus*, with one species, the olm, a blind, unpigmented cave-dweller occurring in Yugoslavia; and *Necturus*, with seven species, the mudpuppies, nocturnal stream dwellers of N. America.

protein Name given to polymers with high relative molecular mass of L-amino acids: they occupy a central position in the architecture and functioning of living matter. Structurally they are divided into two groups, globular and fibrous proteins; and they are often found associated with a non-protein component, forming so-called conjugated proteins. Functionally they act variously as enzymes, as structural elements (e.g. hair and collagen), as hormones, as respiratory pigments, as contractile elements, as antibodies, and as hereditary factors.

proteinase *See* protease.

Proteles cristatus (aardwolf) *See* Hyaenidae.

Proteocephalidea (phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms which possess a quite complex, suckered scolex.

Two or three hosts may be inhabited during development, the final one always being a freshwater vertebrate.

Proterosuchus Well-known representative of the Thecodontia, the ancestral archosaurian stock. According to some authorities, *Proterosuchus* was the first crocodile. It lived in N. America during the Triassic.

Proterozoic *See* Precambrian.

Proteus (family Enterobacteriaceae) Genus of Gram-negative bacteria in which the cells are usually rod-shaped, but may vary from ovoid to filamentous under certain conditions. They are motile with many flagella. They are found chiefly in the intestines and faeces of animals, including humans. Some species can cause disease.

Proteus anguinus (olm, cave salamander; order Urodela (Caudata), family Proteidae) Neotenous salamander, in which the snout is flattened and the body eel-like, with small three-toed forelimbs, two-toed hind-limbs, and a laterally compressed tail. It is white with red gills, but may turn brown after long exposure to light. It feeds mainly on crustaceans. It occurs in underground streams in NW Yugoslavia.

Proteutheria (infraclass Eutheria, cohort Unguiculata, order Insectivora) Suborder comprising the modern tree shrews, e.g. *Tupaia* and *Ptilocercus* (pen-tailed tree shrew), and a large number of extinct forms the earliest of which lived during the late Cretaceous. At that time the early eutherians appear to have diverged to form two distinct stocks, the Leptictidae and Deltatheridiidae, distinguished mainly by the structure of their teeth; both are included in the Proteutheria. There were many evolutionary side-branches which became extinct, but among successful proteutherians some may be ancestral to rodents and others may be ancestral to primates. Proteutheria are often excluded from the Insectivora, or even divided into two or more separate orders, extant forms being assigned to the suborder Scandentia. There are five extant genera, comprising about 20 species.

prothorax The first thoracic segment of an insect, which consists of a cuticular box made up of a pronotum dorsally, propleura laterally, and a prosternum ventrally. The prothorax bears a pair of legs.

prothrombin The enzymatically inactive precursor of thrombin, which is activated by a complex cascade of events requiring the presence of Ca^{2+} (calcium), of proteinaceous thromboplastins, and of a number of additional blood factors. *See also* blood clotting.

Protista Kingdom (in some classifications ranked as a superphylum or phylum) of relatively simple, undifferentiated, unicellular or multicellular organisms, including algae, bacteria, fungi, and protozoans. May be used to include only the bacteria, protozoans, unicellular fungi, and unicellular or simple colonial algae. In most modern classifications bacteria are placed in the kingdom Procaryotae, and the term 'Protista' is considered outdated. Groups such as the foraminifera and radiolarians have a well-established fossil record. The multicellular organisms arose from the protists by various independent routes, possibly as many as 17. They were already a diverse group 1000 million years ago.

Protoaulopora ramosa Small, colonial coral belonging to the subclass Tabulata, found in the Upper Cambrian of Soviet Kazakhstan. With *Bija sibirica* (a doubtful stony coral) it marks the appearance of an important group of reef-forming organisms.

protobranchiate Applied to a primitive type of gill, common to certain pelecypods, which is simple, flat, and horizontal, so that the lower mantle cavity is an inhalant chamber and the upper mantle cavity is an exhalant chamber.

Protoceratidae American offshoot from the main traguloid stem of artiodactyls, ranging from the Oligocene to the Pliocene. They were deer-sized mammals with horn-like structures in the nasal region, above the orbits, and on the upper part of the braincase. The Pliocene *Synthetoceras* had two horn-pairs, the nasal pair being fused into a Y-shape.

Protoceratops andrewsi The first of the horned (ceratopsian) dinosaurs, known from the Middle Cretaceous of Mongolia. It possessed the bony frill and beak characteristic of later forms, but was only 2 m in length and 1.5 t in weight.

protocercal tail Possibly the most primitive type of tail found in fish. The posterior end of the vertebral column is straight, dividing the tail-fin into two equal lobes supported by finrays.

Protochampsa barrionuevoi One of the earliest crocodiles, which appeared first in the Triassic of S. America. It possessed fused nares which opened on the roof of the snout like those of modern crocodiles.

protochordate A member of the non-vertebrate Chordata; the name is applied informally to all living and fossil chordates without skulls and vertebrae.

Protococcidia (subclass Coccidia) Order of little-known protozoa which appear to be parasitic on marine annelids. Only two species have been described.

protoconch The initial (larval) shell of molluscs, often retained at the tip of the spire of the adult shell.

protocone In primitive, triconodont, upper molar teeth, the central cusp where the three cusps form a straight line. Where they are not in line, the anterior inside cusp.

protocooperation An interaction of species populations in which both populations benefit, but neither is dependent on the relationship. *Compare* mutualism.

protogyny (adj. protogynous) Condition in which the female parts develop first: *compare* protandry.

protohemicryptophyte *See* hemicryptophyte.

Protomedusae (phylum Cnidaria) Extinct class of very variable, primitive Cnidaria whose bodies were swollen into radial pouches, sharply separated by radial grooves, usually with incomplete supplementary lobes (which are interpreted as additional oral arms) inserted between the principal lobes or pouches. They are Precambrian, Cambrian, and Ordovician in age.

protonema Early stage in the development of a moss or liverwort. A protonema is produced when a moss or liverwort spore germinates. In mosses it usually consists of green, branching filaments; but it is thalloid (a flat sheet or disc of cells) in *Sphagnum* and *Andreaea*, for example, and in many liverworts. The familiar moss or liverwort plant (the gametophyte) arises from buds which develop on the protonema.

Protoneuridae (damselflies; order Odonata, suborder Zygoptera) Family of slender, delicate damselflies, with narrow wings, which are distinguished from other damselflies by having the first anal vein fused with the wing margins. Nymphs of many species have not been described, but those which have are generally small, with short legs, and caudal gills of varying shape. The family occurs in the tropics, and more than 200 extant species have been described. *See also* venation.

protoplasm Complex, translucent, colourless, colloidal substance within each cell, including the plasma membrane or protoplast, but excluding the large vacuoles, masses of secretions, ingested material, etc. In animals and plants it is differentiated into nucleoplasm (protoplasm in the nucleus) and cytoplasm (protoplasm in the rest of the cell).

protopodite In Crustacea, the base to which a biramous appendage is attached. It consists of a coxa (coxopodite) and a basis (basopodite), the inner (endopodite) and outer (exopodite) parts of the appendage being attached to the basis.

Protopteridae (African lungfish; class Osteichthyes, subclass Dipneusti, order Lepidosireniformes) Small family of freshwater fish which can breathe air with the aid of a pair of airsacs or lungs. They have a somewhat rounded body and long, filamentous, pectoral and pelvic fins. The gills are functional, but poorly developed: lungfish, e.g. *Protopterus aethiopicus* (2 m), often have to rely wholly on their lungs, as they tend to live in stagnant water low in oxygen. During the dry season they make deep burrows in the muddy bottom of the swamp, surrounding themselves with a thin cocoon; this so-called 'aestivation' helps the fish survive when the swamps dry up. There are four species, living in African rivers.

Protopterus annectans *See* aestivation in fish.

Protoreodon Important artiodactyl mammal recorded from the Upper Eocene of N. America. Rather pig-like in build and habits, it is considered a likely ancestor for various ruminant stocks.

protosoma *See* Enteropneusta.

Protosteliales (subclass Protostelidae) Order of slime moulds, with the characteristics of the subclass, containing two families and several species.

Protostelidae (class Acrasiomycetes) Subclass of slime moulds in which the feeding stage consists of simple myxamoebae or small plasmodia. The myxamoebae do not aggregate prior to fruiting. Species are distributed widely, found mainly on dead plant material.

Protosuchus richardsoni Primitive, well-armoured crocodile from the Upper Triassic of N. America. The skull is rather primitive, but modifications of the limbs and girdles result in an improved, quicker gait.

Prototheria (class Mammalia) Subclass comprising the extinct orders Docodonta, Triconodonta (although their inclusion in the subclass is controversial), and Multituberculata, and the order Monotremata, members of which (platypus and echidnas) still survive. Prototherians are distinguished from therians mainly by the skull wall, which in prototherians has a small squamosal and alisphenoid, and by their teeth. The two subclasses began to diverge from a common stock during the late Triassic.

Prototroctes maraena (Australian grayling) *See* Aplochitonidae.

prototroph In bacteriology, a strain of bacteria that has the nutritional requirements of the wild-type or non-mutant species. *Compare* autotroph.

Protoungulata (infraclass Eutheria, cohort Ferungulata) Superorder comprising the orders Condylarthra, Notoungulata, Litopterna, Astrapotheria, and Tubulidentata. The superorder includes the earliest known ungulates from their appearance during the late Cretaceous, when they departed from an insectivorous diet and began to eat plant material, until their radiation, by the end of the Palaeocene, permits them to be grouped in distinct orders from some of which later ungulates are descended. The Tubulidentata, known to have lived in the Miocene and possibly in the Eocene, are animals apparently similar to condylarths and so are included in the superorder, but otherwise they are isolated zoologically and their affinities are obscure.

Protoxaea *See* Oxaeidae.

Protozoa Phylum (division) of eukaryotic, single-celled micro-organisms which show a wide variety of forms. The phylum includes free-living, commensal, mutualistic, and parasitic species, and some important disease-causing organisms. In some classifications the Protozoa are grouped with other simple eukaryotic organisms in the phylum Protista.

protractile mouth *See* protrusible mouth.

Protrogomorpha *See* Sciuridae.

protrusible mouth (protractile mouth) In fish, a structural arrangement of the jaws that enables the animal to protrude (extend) or withdraw the mouth at will. When fully protruded, the cavity of the mouth is enlarged to form a funnel-like space facilitating the uptake of food, e.g. in the family Zeidae (dories).

Protura Class and order of minute (0.6–2 mm long), primitive, apterous, white hexapods, which lack eyes and antennae and have reduced, entognathous, piercing mouthparts. Members of the class are elongate, with segmented legs, the anterior pair used for sensory purposes, the middle and posterior pair for walking. The abdomen carries a pair of short styli (rudimentary limbs) on the basal three segments and the pseudocelli found on the head may represent antennal bases or postantennal organs. Species in this rare group live under bark, stones, or among rotting vegetation, and are sometimes subterranean in habit. Proturans exhibit anamorphosis (the formation of extra abdominal segments after egg hatching), one extra segment being added at each moult. Metamorphosis is simple. There are 118 species, worldwide in distribution, and they are of no economic importance.

provirus DNA transcript of the RNA genome of an RNA tumour virus which has become integrated with the genome of its host cell; under certain conditions the provirus can be activated to regenerate the complete virus.

prowfish *See* Pataecidae; and Zaproridae.

P/R ratio *See* production/respiration ratio.

pruinose Covered with powdery granules; powdery in appearance.

Prunella 1 (*P. modularis*, dunnock) *See* Prunellidae. 2 (selfheals; family Labiatae) Genus of herbs distributed widely in the N. hemisphere and naturalized in Australia.

Prunellidae (accentors; order Passeriformes) Family of small, mainly brown birds which have greyish under-parts, some with chestnut flanks, and slender, pointed bills. They are ground feeders, found in rocky meadows, scrub, and woodland; they feed on seeds and insects, and nest in bushes and on the ground. *Prunella modularis* (dunnock) is a common garden bird in Europe. There is one genus, comprising 12 species, found in Europe and Asia.

Prunus (plums, cherries; family Rosaceae) Genus of trees and shrubs whose flowers have five free petals, five sepals, about 20 stamens, and a single carpel, which sits in a cup formed by the calyx tube but is free from it. The fruit is a one-seeded drupe with a stony inner wall and a fleshy outer one. Many kinds of plums and cherries are cultivated for their fruits, and other species are grown for their flowers. There are about 200 species, most of which occur in the northern temperate zone, but some of which are native to the Andes and to the Asian tropics.

Prunus serotina (American cherry) Fast-growing, light-demanding, gregarious tree of the temperate deciduous forests of N. America.

Prymnesiophyceae (Haptophyceae) Class of predominantly unicellular, flagellated algae in which there are two smooth (whiplash-type) flagella, and a structure called a haptonema: a filamentous appendage which may be short, or long and whip-like, and which is believed to function mainly in attaching the organism to a solid surface. Species are predominantly marine, often forming a major component of the phytoplankton in some regions. Many species have a cell covering of many small scales; in some species these scales are impregnated with calcium carbonate and are known as coccoliths. There are four orders.

psalterium *See* omasum.

Psaltria (pygmy tits) *See* Aegithalidae.

Psaltriparus (bushtits) *See* Aegithalidae.

psammo-littoral zone The water's-edge zone of sandy shores, both marine and freshwater, where the microscopic plant and animal communities forming the psammon are most prolific.

psammon The microscopic flora and fauna of the interstitial spaces between sand grains of sea-shore and lake-shore areas.

psammosere The characteristic sequence of changes associated with stages in a plant succession developed on sand-dunes. *See also* succession.

Psathyrella (family Coprinaceae) Genus of fungi in which the mushroom-shaped fruit bodies are fragile and have a central brittle stipe. The spore print is black or dark brown. There are many species, found on the ground, on tree-stumps, etc., often growing in clumps.

Pselaphidae (class Insecta, order Coleoptera) Family of tiny, red or yellowish beetles, 0.75–3.5 mm long. They have an ant-like appearance, with a narrow thorax, and a very broad, non-flexible abdomen. The elytra are short, with several abdominal segments exposed. One group, with much reduced antennae and maxillary palps, lives in ants' nests. Some feed on food regurgitated by ants and produce from the base of the abdomen a sweet substance attractive to ants. A second group, has 11-segmented antennae and unusually long clubbed palps, especially in males. It is found in leaf litter, under bark, or more loosely associated with ants. Larvae are poorly known. There are 5000 species, mostly tropical.

Psenes arafurensis (eyebrow fish) *See* Nomeidae.

Psettodes erumei (Queensland halibut) *See* Psettodidae.

Psettodidae (toothed flounder; class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Small family of marine flatfish with spiny rays in the dorsal fin, which begins well back on the body. The head has a mouth with strong teeth. The eyes may be on either the left or right side of the body. Some species, e.g. *Psettodes erumei* (Queensland halibut), 64 cm, are considered good eating by local fishermen. There are possibly five species, found in African and Indo-Pacific waters.

Pseudaphritis urvilli (congilli) *See* Bovichthyidae.

pseudergate Member of the labouring caste in lower families of termites, which is capable of metamorphosis into a reproductive.

Pseudevernia (family Hypogymniaceae) Genus of lichens in which the thallus is more or less fruticose. *P. furfuracea* closely resembles oakmoss (*Evernia*

prunastri) but is black on the under-side, and bears isidia rather than soredia. Apothecia are rarely formed. This species is common on a range of substrates in hilly districts of the north and west of Britain.

Pseudidae (order Anura (Salientia), suborder Procoela) Small family of amphibians which are related to the aquatic tree-frogs (hylids). They have an extra phalanx on each digit, and the thumb is opposable. They are found in S. America.

pseudobranch Small, gill-like structure that is the remnant of the primitive gill of the mandibular arch in sharks and bony fish.* Despite its origin, it probably has a glandular rather than a respiratory function. In most bony fish it is found on the inner side of the opercular base.

Pseudocarcinas gigas (mud crab; order Decapoda, family Xanthidae) Species of large, edible mud crabs which can grow up to 40 cm wide. They occur off the south coast of Australia.

pseudocarp (false fruit) Fruit in which the ripened ovary and its contents are combined with another structure, often the receptacle.

Pseudochromidae (dottyback; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have an elongate body, large eyes, and a large, soft-rayed, dorsal fin preceded by about three spiny rays. The tail-fin and pectoral fins are rounded. Found among rocks and coral heads, *Pseudochromis fuscus* (brown dottyback), 10 cm, and its relatives are colourful, agile fish, found in the Indo-Pacific region. There are several species.

Pseudochromis fuscus (brown dottyback) *See* Pseudochromidae.

pseudocyphella Depression or pore in the surface of the thallus in certain types of lichen; pseudocyphellae are visible as small pale or white dots.

pseudo-epithecium In the fruiting bodies of certain ascomycetes, a layer above the hymenium consisting of the tips of paraphyses in an amorphous matrix.

Pseudogramma polyacanthus (one-spot dottyback) *See* Pseudogrammidae.

Pseudogrammidae (dottyback; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of elongate marine fish, closely related to the Pseudochromidae. They have about seven spiny rays in the dorsal fin; the soft dorsal and the other fins have a rounded profile. Like the Pseudochromidae, they have an interrupted lateral line and conspicuous eyes. *Pseudogramma polyacanthus* (one-spot dottyback), 8 cm, is one of the species widely distributed along African and Indo-Pacific coastlines. There are at least six species.

Pseudolarix (golden larch; family Pinaceae) Genus of one species of deciduous conifers, close to *Larix*, but with female cones that break up when ripe, pointed cone scales, and male cones borne in bunches on spur shoots. The genus is native to China.

Pseudolestidae *See* Lestoideidae.

Pseudomonadaceae Family of Gram-negative bacteria; the cells are straight or curved rods, and are typically motile with polar flagella. Most are aerobic chemo-organotrophs. There are four genera, found in a wide range of habitats. Some species are free-living, others are pathogenic in plants or animals.

Pseudomonas (family Pseudomonadaceae) Genus of Gram-negative, rod-shaped bacteria which are typically motile with polar flagella. Species are capable of breaking down a wide range of organic compounds and are important agents of mineralization. There are many species. They are common in soils, and in fresh and marine waters. Some can be pathogenic, for example *P. aeruginosa* can cause infection of burns, *P. mallei* causes glanders, and *P. solanacearum* can cause wilt in a variety of plants.

pseudomorph *See* metasomatism.

Pseudomyrmecinae (order Hymenoptera, suborder Apocrita, family Formicidae) Subfamily of slender, arboreal ants, which have two petiolar nodes, a sting, and well-developed eyes. There are about 200 species. They are restricted to the tropics, and inhabit hollow stems and twigs.

pseudoparaphyse One of the sterile, thread-like filaments found in the perithecia and pseudothecia of certain fungi. They arise in the upper portion of the fruit cavity and grow downwards.

pseudoperithecium *See* pseudothecium.

pseudoplasmodium In cellular slime moulds, a plasmodium-like structure formed by the aggregation of many separate amoeboid cells.

Pseudoplesiopidae (false roundhead; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish with an elongate body, large eyes, and a long, single, dorsal fin which, like the other fins, has a rounded profile. *Pseudoplesiops typus* (false roundhead), 50 cm, is one of the colourful species frequenting the coral reefs between Indonesia and Australia. There are several species.

Pseudoplesiops typus (false roundhead) *See* Pseudoplesiopidae.

Pseudopleuronectes americanus (Atlantic winter flounder) *See* Pleuronectidae.

pseudopodetium In certain lichens, a fruticose part of the thallus upon which ascocarps (when present) are borne; a pseudopodetium may resemble certain types of podetium but differs in its mode of development.

pseudopodium In amoeboid cells, a protrusion, usually temporary, of the cell body, which functions in locomotion and in the ingestion of food particles.

pseudorumination *See* refection.

Pseudoscorpiones (pseudoscorpions; class Arachnida) Order of minute arachnids whose name refers to their large, scorpion-like, chelate pedipalpi which do not, however, possess a stinging organ. Pseudoscorpions are flattened, with the oval opisthosoma joined broadly to the prosoma. Most

are black, brown, or brownish-green, and have two pairs of respiratory tracheae. Few are more than 5 mm long, although the largest species reaches 12 mm. The sides of the carapace bear one or two pairs of eyes, and the small chelicerae produce silk for the construction of moulting, overwintering, and brooding chambers. Prey items are caught by means of the large, chelate pedipalps, and are passed to the chelicerae where digestive juices are injected. Most species live in crevices and the humid conditions found under bark, plant litter, etc., and feed on Collembola, caterpillars, and ants. Some pseudoscorpions disperse by phoresy (clinging to the legs of passing flies and other animals). Courtship displays occur, and may involve pheromones; and there are indications of presocial behaviour in this order of often gregarious species. 2000 species occur worldwide, of which 25 can be found in the UK. Some species inhabit houses and are cosmopolitan, hunting booklice, nymphal bedbugs, and other small insects.

pseudoscorpions *See* Pseudoscorpiones.

Pseudosindora (family Leguminosae, subfamily Caesalpinoideae) Genus of one species, which is an important timber tree of the Bornean peat swamps (swamp sepetir).

Pseudostega (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans in which the colony stands erect, and is cylindrical or with two layers of individuals in cross-section. The individuals are arranged in longitudinal rows. The division occurs from the Cretaceous to Recent.

pseudostem False stem formed of the swollen leaf bases, as in the banana.

pseudo-steppe Area with steppe-like vegetation which occurs outside Eurasia. The term 'steppe' strictly refers to the temperate grassland of Eurasia. However, it has also been applied to vegetation on the southern fringe of the Sahara (the Sahel zone), in parts of Namibia, and in SW Australia.

Pseudostigmatidae (damselflies; order Odonata, suborder Zygoptera) Family of damselflies whose members have very slender, elongated abdomens, and are the largest extant odonates. The nodus of the wing is close to the base, the pterostigma is often weak, and the second branch of the median vein arises a long way distally from the nodus. The larvae inhabit a variety of habitats, including water-filled holes in rotting logs and branches of trees. The caudal gills are often foliaceous. The family occurs in tropical rain forests, and 35 extant species have been described. *See also* venation.

Pseudosycidium The first of the Charales, a distinct, new evolutionary line of green algae which arose during the Silurian and whose method of reproduction was sexual. Well-developed male (antheridia) and female (oogonia) organs can be identified, the secretion of calcium carbonate around the female organs assisting preservation. *Pseudosycidium* appeared in the Upper Silurian.

pseudothecium (pseudoperithecium) An ascocarp which resembles a perithecium but differs from it in its mode of development, and in that it contains bitunicate asci.

Pseudotsuga (Douglas fir; family Pinaceae) Genus of evergreen conifers with leaves like *Abies* (silver fir), but with narrow, scaly buds like *Fagus* (beech). Female cones have long-projecting, three-lobed bract scales which are distinctive. *P. menziesii* is planted extensively for forestry. There are five species, two occurring in western N. America, two in China, and one in Japan.

Psidium (family Myrtaceae) Genus of small trees and shrubs, many with edible fruits, notably *P. guajava* (guava), which is widely naturalized. There are 140 species, occurring in neotropical regions.

Psilocybe (family Strophariaceae) Genus of fungi in which the fruit bodies are mushroom-shaped. The cap is moist and fleshy, and is typically more or less conical. The spore print is purplish-brown or brown. *Psilocybe* species are found on dung, twigs, lawns, etc. When eaten, the fruit bodies have hallucinogenic properties.

psilophytes *See* Psilophytopsida.

Psilophytopsida Primitive pteridophytes, which were the earliest vascular plants, from the Silurian and Devonian. They had slender, tapering, leafless, or scale-bearing stems up to 50 cm high, often with cone-shaped sporangia at the top. Recent classifications also include the living psilophytes in this group. The modern psilophytes (Psilopsida) comprise four or five plant species of the tropics and subtropics, of which *Psilotum* ('whisk fern') is the best known.

Psilotaceae (order Psilotales) Family of very ancient and primitive vascular cryptogams (Pteridophyta), characterized by forked stems bearing small, scale-like appendages (*Psilotum*), or flattened leaves with a single vein (*Tmesipteris*), creeping rhizomes without roots, and spore-capsules fused in pairs (*Tmesipteris*) or in triads (*Psilotum*). The gametophytes are cylindrical and subterranean, and live by means of a mycorrhizal fungus as saprophytes. There are two genera, and four or five species, the only living representatives of the order, probably the most primitive of living vascular plants, and possibly related to the Devonian fossil group the Psilophytales. *Tmesipteris* is confined to the Australasian region.

Psilotum (whisk ferns; family Psilotaceae) Genus of very primitive vascular plants without true roots, and with the spore-capsules borne in fused triads on the upper parts of the forking stems, in the axils of tiny scales. There are no real leaves, but the ridged stems are green, and act as photosynthetic organs. There are three species, one occurring widely in the tropics and subtropics, including Australasia and the Pacific islands, extending into S. Spain and into the southern part of the USA. The other two are more localized.

Psittacidae (lories, cockatoos, parrots; order Psittaciformes) Family of small to large, very colourful birds with characteristic deep bills, the upper mandible of which is large, and decurved to form a hook, the lower mandible being upcurved and smaller. Parrots have large heads, short necks, thick, prehensile tongues, and their nostrils are set

in a fleshy cere at the base of the bill. Their toes are zygodactylous. They feed mainly on seeds and fruit, inhabit forest and more open country, and nest in holes in trees or in termite mounds. There are about 80 genera, comprising more than 340 species, found in Africa, S. Asia, Australasia, C. and S. America, and the Pacific islands.

Psittaciformes (lories, cockatoos, parrots; class Aves) Order which comprises one family, Psittacidae, but which is sometimes split into three—Loridae, Cacatuidae, and Psittacidae.

psittacosis Disease caused by the bacterium *Chlamydia psittaci* (formerly believed to be a virus). The disease occurs in parrots and related birds (including budgerigars) and can be contracted by humans, for example on inhalation of contaminated dust from the cage of a diseased bird. In humans the disease is similar to influenza and can be severe.

Psittirostra (Hawaiian honeycreepers) *See Loxioides*.

Psophiidae (trumpeters; order Gruiformes) Family of large, rounded birds which have short, stout bills, long necks, rounded wings, short tails, and long legs. Their plumage is mainly black, with a purple gloss on the neck, and the head and neck feathers are very soft. Tertiaries and secondaries have long, hair-like strands, and are white, grey, or brown. Trumpeters are gregarious and terrestrial, rarely flying, inhabit forests, feed on insects and vegetable matter, and nest in tree holes. There is one genus, *Psophia*, with three species, found in S. America.

Psychidae (bagworms; order Lepidoptera) Family of moths in which the males are always winged, while in the females the wings are often reduced or absent. The larva lives within a case that is often characteristic of the species, and is often constructed of leaves, twigs, or sand grains. Most larvae feed on detritus. The family is distributed worldwide.

Psychodidae (moth flies, sand flies; class Insecta, order Diptera, suborder Nematocera) Family of minute, moth-like flies in which the legs, body, and wings are covered in long, coarse hairs and often scales. Ocelli are lacking, and the wings have R_s four-branched, and there are no obvious cross veins. The larvae are mostly amphipneustic, and usually aquatic or saprophagic. Females of some genera, e.g. *Phlebotomus*, are blood suckers, attacking vertebrates. These include the 'sand fly' which is known to be a vector of leishmaniasis and other related human diseases. The family has a worldwide distribution, and more than 500 species are known to exist. *See also* venation.

Psychotria (family Rubiaceae) Large genus of trees and shrubs, many members of which have colourful inflorescences. There are 700 species, occurring in the tropics and subtropics, in regions with a humid climate.

Psychrolutes paradoxus (tadpole sculpin) *See* Psychrolutidae.

Psychrolutidae (tadpole sculpin; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish with a large head, stout body, but strongly tapering tail; the pectoral fins are rather large. *Psychrolutes paradoxus* (tadpole sculpin), 6 cm, inhabits waters of moderate depth (100–300 m). Some authors place these fish in the family Cottidae. There are about five species, occurring in the N. Pacific.

psychrometer Hydrometer with a wet-bulb and a dry-bulb thermometer. *See also* whirling psychrometer.

psychrophile Organism that grows best at low temperatures, e.g. 15 °C or below.

psychrotroph Organism that can grow at low temperatures (e.g. 15 °C or below) but that grows better at higher temperatures.

Psyllidae (order Hemiptera, suborder Homoptera) Family of homopterans in which the rostrum arises between the bases of the front pair of legs, and the hind pair of legs is modified for jumping. Psyllids suck the sap of many different kinds of plants and some of them cause the formation of galls. The immature stages are almost immobile and cannot jump. There are about 1300 species, distributed worldwide.

PTC Plasma thromboplastin component. *See* blood clotting.

Pteraspidimorphi Glass of jawless vertebrates which have an eel-like body, lack paired fins, and have two semicircular canals, and a skeleton not consisting of true bone. The class includes the fossil order Pteraspidiformes, and the extant Myxiniformes (hagfish). Some authors place the Myxiniformes with the class Cephalaspidimorphi.

Pteraspidomorpha Superorder of jawless vertebrates which includes the order Myxiniformes (hagfish).

Pteridium (bracken; family Dennstaedtiaceae) Monospecific genus of fern, with deep, far-creeping rhizomes, and much dissected, pinnate fronds. The sori are continuous all round the edges of those pinnae that produce them, and are protected both by the recurved margin of the pinna, and by a delicate indusial flap on their inner side. It is one of the world's most common ferns, and a pest in many pasture lands in temperate climates, since it is not usually eaten by animals and is encouraged by burning. The genus is cosmopolitan, except for the Arctic and temperate S. America.

Pteridomorphia (phylum Mollusca, class Pelecypoda) Subclass of pelecypods, most of which are sedentary, epifaunal, and byssate or cemented. The most specialized genera have a reduced anterior adductor muscle and foot, and in some forms they are absent. The shells are variable in shape and composition; they may be aragonite, calcite, or both. They have a duplivincular ligament, unique to certain members of the subclass, and the dentition is variable. They first appeared in the Lower Ordovician.

Pteridophyta (pteridophytes) Division of the plant kingdom, comprising the vascular cryptogams.

They are flowerless plants exhibiting an alternation of two distinct and dissimilar generations. The first is a non-sexual, spore-bearing, sporophyte generation. It usually appears as a relatively large plant, with stems containing vascular tissue that conducts water and dissolved solutes through the plant, and usually bears the leaves and roots. Spores are produced in sporangia that are either attached to the leaves (as in ferns) or are on specialized scales grouped into cones (as in horsetails and clubmosses), or in the axils of leaves on unspecialized stems (as in Psilotaceae and some clubmosses). The second is a sexual, gametophyte generation, in which the plants generally are relatively small, and without differentiation of stem, leaves, or roots. These plants bear male (antheridia) and female (archegonia) sex organs, together or on separate plants. When the eggs in the archegonia are fertilized by sperms from the antheridia, an embryo results: this can grow into a new sporophyte generation. The cells of the sexual, gametophyte generation each contain a single chromosome set in their nuclei (the haploid condition). Those of the sporophyte generation each contain a double chromosome set (the diploid condition), reduced to a single set in the spores. The Pteridophyta, in the wide sense as it is usually understood, includes the classes Lycopsida (families Lycopodiaceae, Selaginellaceae, and Isoetaceae), Sphenopsida (or Arthropsida; family Equisetaceae), Psilopsida (family Psilotaceae), and Filicopsida (the various families of ferns). They first enter the fossil record in the Silurian.

pteridophytes *See* Pteridophyta.

Pteridospermales (seed ferns) Extinct gymnosperm order, which were the earliest seed plants and flourished in the Carboniferous, before disappearing in the Cretaceous

Pteriina (class Pelecypoda, order Pterioida) Suborder of pelecypods which possess the general characteristics of the order. Mature individuals are byssate or cemented by the right valve. The shell shape and structure varies. The ligament is very variable, and the gills are filibranch or eulamellibranch. They first appeared in the Ordovician.

Pterioida (phylum Mollusca, class Pelecypoda) Order of pelecypods that are byssate or cemented, and generally pleurothetic. Normally they are unequilateral and unequivalve, and their variable shell composition may be crossed-lamellar, prismatic-nacreous, or foliate. The musculature is anisomyarian or monomyarian. The ligament is extremely variable. The gills are eulamellibranchiate or filibranchiate. They first appeared in the Ordovician.

Pteris (family Adiantaceae) Genus of ferns with creeping rhizomes and long pinnae, continuously bordered by sori, which are protected only by the recurved margins of the pinna (without an inner membranaceous indusium, as in *Pteridium*). The genus is largely tropical.

Pterobranchia (subphylum Stomochorda) Class of minute, fixed, colonial, deep-sea organisms which secrete an external cuticular skeleton in which they are housed. The mesosoma is small but carries one or more pair of arms bearing tentacles (the lophophores). The metasoma consists of a long stalk (peduncle) by which the individual is attached. The branchial apparatus is rudimentary.

Pterois volitans (lionfish) *See* Scorpaenidae.

Pterocarpus (family Leguminosae, subfamily Papilionatae) Genus of trees which have pinnate leaves, and rather large leaflets. The flowers are showy yellow racemes, in lax panicles. The fruit is a disc-like, flat, indehiscent pod, obliquely beaked, often membranaceous at the edges, containing one seed. The trees yield dark, fine-grained, superb cabinet timber (Amboyna, angsana, sena from *P. indicus*, padauk from several continental Asian species). The cut bark yields a bark resin (kino) which is astringent and medicinal. There are 30 species, with a pantropical distribution.

Pterocarya (wing nuts; family Juglandaceae) Genus of deciduous trees which have large, pinnate leaves. The twigs have septate pith, and the buds are usually naked. The flowers are in unisexual catkins. The fruit is a nut with two leafy wings. The trees yield useful timber. There are 12 species, occurring from the Caucasus to Japan.

pterochore *See* -chore.

Pteroclidae (sandgrouse; order Columbiformes) Family of medium-sized birds which have brown and grey, barred, spotted, and mottled upper-parts; yellow, chestnut, white, and black under-parts; and face markings. They have short, conical bills; short necks; long, pointed wings; and a medium to long tail. Their legs are short and feathered. They are gregarious and terrestrial; inhabit open plains, desert, and brush; feed on seeds; and nest on the ground. There are two genera, comprising 16 species, some migratory, found in Europe, Africa, and Asia.

Pterocnemia pennatus (Darwin's rhea) *See Rhea*.

Pterodroma (petrels; family Procellariidae) Genus of medium-sized, long-winged petrels, which are mainly sooty brown and grey, many with white under-parts, and some with white collars, rumps, or tails. Their tails are mainly rounded. They are pelagic, feed on fish and plankton, and nest on the ground or in burrows. There are about 25 species, breeding on islands in the southern oceans.

Pteroglossus (toucans; family Ramphastidae) Genus of medium-sized toucans, which have a black head, throat, and back, and a green gloss on the back. The rump is bright red, the under-parts are yellow with bands of red and black across the breast. The bill is off-white, black, and red. They inhabit forest, feed on fruit, and nest in tree holes. There are nine species, found in C. and S. America.

Pteromalidae (jewel wasps; suborder Apocrita, superfamily Chalcidoidea) Family of minute (2–4 mm long), usually black or metallic green wasps, many of which are important in the control of crop pests. This large and abundant group has a complex taxonomy and is sometimes broken into several families. Jewel wasps are parasitic on a wide range of hosts, including ants, the larvae of Lepidoptera,

Coleoptera, and Diptera, other chalcidoids, and the oothecae of cockroaches and spiders, while others are hyperparasites (parasitic on the larvae of other parasitic wasps).

Pterophoridae (plume moths; order Lepidoptera) Widespread family of small moths with few species. Adults are characterized by the division of the wings into plumes. Superficially they resemble the Alucitidae, but the forewings are cleft into two, three, or four, and the hindwings into three. Some species have undivided wings. Larvae are external or internal feeders, particularly on Compositae.

Pterophyllum (angelfish) *See* Cichlidae.

Pteropoda Informal, non-taxonomic name given to the pteropods, two orders of marine Gastropoda. *See* Gymnosomata; and Thecosomata.

Pteropodidae *See* Megachiroptera.

pteropod ooze Deep-sea ooze in which at least 30% of the sediments consists of the shells of planktonic small gastropods (known as pteropods or 'wing-footed' snails). The shells are aragonitic and as aragonite solubility increases rapidly with depth, pteropod ooze is restricted to water depths less than 2500 m.

pteropods *See* Opisthobranchia; Pteropoda; and pteropod ooze.

Pterosauria Mesozoic order of flying reptiles, which were particularly numerous in the Jurassic, but survived until late Cretaceous times. Their fossil skeletons suggest that they could not stand upright on land, and so it is assumed that their mode of life involved swooping over the sea to catch fish. Their remains are always associated with marine deposits.

pterostigma Pigmented spot on the anterior margin of the wing of an insect.

Pterostylis (family Orchidaceae) Genus of terrestrial orchids, which have thin, soft, fleshy leaves held in a radical rosette. The plants produce one or more underground tubers. The flowers are green, white, or brownish, and either solitary or held in a terminal raceme. The middle sepal and upper two petals form a hood. The two lower sepals form a lower lip and are often extended into long, thin tails. The lower lip is either incurved or reflexed. The labellum is usually narrow. The fruit is a three-celled capsule containing numerous fine seeds. There are about 60 species, nearly all endemic to Australia. Many species are cultivated as ornamentals.

pterygoid One of the elements of the bar that forms the upper jaw in elasmobranch fish and one of the bones of the upper jaw in many teleost fish. In other vertebrates the pterygoid forms part of the roof of the mouth, but in Squamata it continues to bear teeth.

Pterygotus deepkillensis One of the eurypterids, a rather rare group of fossil arthropods that includes the largest known fossil arthropods, some individuals growing to 3 m in length. *P. deepkillensis* is one of the earliest and is known from the Lower Ordovician of N. America.

pteryoglutamic acid *See* folic acid.

Pthirus gorillae *See Pthirus pubis*.

Pthirus pubis (crab louse, pubic louse, papillon d'amour; order Phthiraptera, suborder Anoplura, family Pthiridae) Species of sucking louse which is parasitic on humans and feeds on blood. The insect is very broad in relation to its length, with long, massive claws to clasp hair. It is restricted to regions where the hair is thick and widely spaced: the pubic and peri-anal regions, armpits, chest, legs, upper arms, beard, and eyelashes; it is also sometimes found on the scalps of babies and of older people who have red hair. The louse is much more slow-moving than the two species of *Pediculus* parasitic on humans, and will remain holding on to hairs with the legs of both sides of the body and its mouthparts inserted into the skin, taking blood intermittently, for several hours. The eggs are glued to the hair very close to the base. There is only one other species in the Pthiridae, *Pthirus gorillae*, which is parasitic on the gorilla.

Ptiliidae (class Insecta, order Coleoptera) Family of minute beetles, less than 2 mm long, which includes the smallest known beetle, *Nanosella fungi*, 0.25 mm. Usually they are convex and very shiny, but some have a conspicuous pubescence. The wings are narrow, with much reduced venation and a fringe of long hairs. The antennae are hairy, with loose clubs. They are found in fungi, decaying vegetation, and under bark. *Ptilium myrmecophilum* lives in ant nests. There are 300 species.

Ptilinopus (fruit doves; family Columbidae) Genus of small to medium-sized, plump doves which have short to medium-length tails. Most are mainly green with areas of contrasting colours; some are strikingly orange. They inhabit forests and cultivated areas, feed on fruit and berries, and nest in trees and shrubs. There are 49 species found in Malaysia, the Philippines, Indonesia, New Guinea, Australia, and the Pacific islands.

ptilinum An inflatable sac above the base of the antennae in Diptera (true flies) of the section Schizophora (suborder Cyclorrapha). It is used by the emerging fly to break open the puparium and to force a path through the pupation substrate.

Ptilocercus (pen-tailed tree shrew) *See* Proteutheria.

Ptilogonatidae *See* Bombycillidae.

Ptilonorhynchidae (bowerbirds, catbirds; order Passeriformes) Family of medium-sized to large birds, which are mainly black, grey, or blue, marked with other brilliant colours. They have stout bills; short to medium, rounded wings; and short to long tails. Some species have a crest or coloured ruff of feathers. They inhabit forests, feed on insects, fruit, and seeds, and nest in trees. The males build an elaborate bower or display ground which is decorated with coloured flowers, berries, and other objects. There are eight genera, comprising 18 species, found in New Guinea and Australia.

Ptilotus (family Amaranthaceae, subfamily Amaranthoideae, tribe Amarantheae) Genus of herbs and

shrubs which are found in both arid and humid habitats. The have entire, alternate or opposite leaves without stipules. The flowers are usually bisexual, and regular, with four or five segments of the perianth which are often fused. They are axillary and solitary, or in cymes. There are 1–5 stamens and a uni-ovular, superior ovary. In several species the flower head is dry, membranaceous, and colourless; in other species flowers are bright and showy. The fruit is a nut or berry, and the seed has a tough, shiny testa. A few species are cultivated as ornamentals. There are 101 species. Almost all of them are endemic to Australia, but some are also found in Malaysia.

Ptinidae (spider beetles; class Insecta, order Coleoptera) Family of small beetles, 2–5 mm long, with a spider-like appearance; the thorax is narrow and rounded, covering the head, the abdomen is globular, the legs long. Some are smooth and shining, but others have elytra covered with dense pubescence. Larvae are white, curved and fleshy, with tiny legs. They feed in dried stored products, skins and carcasses. They are common pests in homes and warehouses. Their natural habitat is in nests of birds, mammals, and ants. There are 700 species.

Ptychodactiaria (subclass Zoantharia) A small order, containing two genera, of Coelenterata with prim..ive musculature, nematocysts, and mesenterial structure (they lack ciliated tracts) in anemone-like polyps. They are often regarded as a family of the order Actiniaria.

Ptychosperma (family Palmae) Genus of palms, a few of which are in cultivation. They are clump-forming, with pinnate leaves, the leaflets being blunt, and praemorse, with a crown-shaft. The inflorescences are sparsely branched, below the crown-shaft; two male flowers flank a female. The fruits are fleshy, and showy. There are 44 species, occurring in the Kei Islands, New Guinea, Solomon Islands, Micronesia, and Queensland.

pubescent Covered with soft hair; downy.

pubic louse *See Pthirus pubis*.

pubis In tetrapods, the anterior, ventral part of the pelvis.

Puccinia (family Pucciniaceae) Genus of rust fungi, which form two-celled teliospores. They parasitize monocotyledonous and dicotyledonous plants throughout the world. Many species cause diseases of economic importance: for example, *P. graminis* causes black-stem rust of wheat, *P. menthae* causes mint rust. There are about 3000 species.

Pucciniaceae (order Uredinales) Family of rust fungi in which the teliospores are stalked (pedicellate) and may have one, two, three, or more cells, depending on the genus. There are many genera. The family includes a number of important plant pathogens.

puddled soil (poached soil) Soil in which the structure has been destroyed by the physical impact of rain drops, by tillage when wet, or by trampling by animals.

puerperal fever (childbed fever) Acute fever with septicaemia occurring after childbirth; puerperal fever may result from infection with any of a number of bacteria, including species of *Streptococcus* and *Clostridium*.

Puerto Rican parrot (*Amazona vittata*) *See Amazona*.

puff adder *See Bitis arietans*.

puff-ball Common name for the fruit body formed by some fungi of the Gasteromycetes. Puff-balls are more or less spherical, and the spores that develop inside them are released through pores or cracks in the peridium.

puffbirds *See* Bucconidae; *Notharchus*; and Piciformes.

pufferfish *See* Tetraodontidae.

Puffinus (shearwaters; family Procellariidae) Genus of mainly black or sooty-brown seabirds many of which have white under-parts. They have long, slender bills, medium-length wings, and short tails. They are pelagic and gregarious, feed on fish, and nest in burrows. There are 16 or 17 species, breeding on islands in most oceans, many undergoing migrations between southern and northern oceans.

pugs *See* Geometridae.

pulmonary Pertaining to the lungs, e.g. 'pulmonary artery', and 'pulmonary vein', the blood vessels carrying blood to and from the lungs.

Pulmonata (phylum Mollusca, class Gastropoda) Subclass of mainly terrestrial gastropods, with some aquatic members, in which the anterior mantle cavity is modified into a lung. A few have small, secondary gills. The shell, if present, can be quite variable in shape. Members of only one family have an operculum. Individuals are hermaphroditic. The subclass first appeared in the Mesozoic.

pulp cavity The internal cavity of a vertebrate tooth, containing connective tissues, blood vessels, and nerves, and connected to the tissues in which the tooth is embedded.

pulque *See Agave*.

pulse **1** The heart beat, as this is perceived through the throbbing of an artery. **2** The edible seeds of any leguminous plant. **3** An alternative term for an algal bloom. **4** *See* pulse labelling.

pulse labelling Technique using radioisotopes for the measurement of the rates of synthesis of compounds within living cells. A suspension of cells or organelles is exposed to a small quantity of isotope for a brief period (seconds or minutes), hence the term 'pulse'. This is achieved through the addition to the suspension of a much larger quantity of the stable (unlabelled) isotope of the same compound following the required period of exposure to the radioisotope. The effect of competition between the two isotopes is to reduce to a negligible level the further uptake of the latter. Measurement of the levels of activity in samples under various experimental conditions can yield useful information regarding the factors influencing the uptake and metabolism of compounds.

pulverulent Dusty; powdery; covered with powder.

pulvinate Cushion-shaped; swollen; convex.

pulvinus *See* Ischnocera.

Puma (order Carnivora, superfamily Feloidea, family Felidae) Genus of Felidae, sometimes included in *Felis*, containing a single species *P. concolor* (catamount, cougar, Mexican lion, mountain lion, painter, panther, or puma). The puma is found from S. Canada to Tierra del Fuego, through savannah, tundra, and all but the densest forest types; after the leopard, it is the most widespread cat. Because of persecution it is now rare in many parts of its range.

puma (*Puma concolor*) *See Puma*.

pumice Extremely vesicular, frothy, natural glass, having a high silica content and low density.

punah *See Tetramerista*.

punas Arid alpine vegetation on high plateaux along the western side of the Andes. It comprises sparse, tufted grasses, and large, hardy, cushion plants. The pamirs of Tibet are a similar vegetation type.

punctate 1 Applied to any structure that is marked by pores or by very small, point-like depressions. 2 Applied to a type of brachiopod shell structure in which fine tubes or pores extend from the inner to almost the outer surface.

punctiform Dot-like in appearance.

punctuated equilibrium Comparatively recent theory of macro-evolution which stands in opposition to the classical interpretation of phyletic gradualism. It argues that the anagenetic component in evolution is small, and that the speciational component is overwhelmingly more important. According to this view, most lineages are characterized by stasis for the greater part of their existence, the key changes being compressed into geologically very short periods of time. *See also* rectangular speciation.

Punica (family Punicaceae) The only genus of its family, with two species of deciduous shrubs, occurring from SE Europe to the Himalayas (*P. granatum*) and Socotra. *P. granatum* is the pomegranate, which is widely cultivated.

Punicaceae Family of one genus of plants, related to the Lythraceae, in which the leaves are simple, spiral, and without stipules. The flowers are perigynous, with 5–8 sepals and petals, many stamens, and many carpels which are adnate to the receptacle. The fruit is seated on the persistent calyx, with a leathery rind, and numerous seeds with partly fleshy leaves.

pupa The stage in the life cycle of an insect during which the larval form is reorganized to form the final, adult form. Pupae are frequently inactive, forming a hard shell (chrysalis) or silken covering (cocoon) about themselves while the very large changes associated with becoming adult take place.

pupil *See* eye.

Purbeckian A late Jurassic stage or formation, the type section of which is found in S. England. The sediments were deposited under intertidal to brackish freshwater conditions.

purga *See* buran.

Purgatorius The earliest genus of the Primates, known from the earliest Palaeocene, and claimed also from the latest Cretaceous.

purine Basic, nitrogenous compound resembling a six-membered pyrimidine ring fused to a five-membered imidazole ring. The two principal purines, adenine and guanine, are major constituents of nucleic acids.

purlieu 1 Land that has been disafforested, generally lying adjacent to a forest. 2 Private land that adjoins a royal forest.

purple emperor *See Apatura iris*.

purple granadilla (*Passiflora edulis*) *See* Passifloraceae.

purple membrane In some strains of *Halobacterium* species, a specialized region of the cell membrane that contains bacteriorhodopsin. The purple membrane functions in a unique energy-yielding process in which the energy of sunlight is harnessed in the absence of photosynthesis.

purple non-sulphur bacteria *See* Rhodospirillaceae.

purple sulphur bacteria *See* Chromatiaceae.

purpresture Trespass by building or otherwise disturbing forest land. *Compare* perpresture.

purse-web spiders *See* Atypidae; and *Atypus affinis*.

push moraine *See* moraine.

Putapacyathida (class Monocyathea (Regulares)) Order of usually solitary Lower Cambrian archaeocyathids. The conical or cylindrical cup is normally formed from complex outer and inner walls. No radial links or septa occur. The walls are connected by tabulae. Dissepiments are sometimes present. The order contains three families, comprising seven genera.

putrefaction Anaerobic digestion by bacteria of proteinaceous material (e.g. meat) with the concomitant production of malodorous substances.

puy 1 A volcanic hill in the Auvergne region of France. 2 Any steep-sided tower of volcanic rock, e.g. the Devil's Tower, Wyoming, USA, and Shiprock, New Mexico, USA. It consists of the resistant central plug or neck of a former volcano. *See also* volcanic plug.

P-wave Primary seismic wave, propagated by alternate compression and expansion of the medium.

pyaemia Type of septicaemia in which pyogenic bacteria occur in the bloodstream.

pycnidiospore Conidium that is produced inside a pycnidium.

pycnidium Flask-shaped or spherical structure within which conidia are formed in certain types of fungi. Conidia are released via a pore in the wall of the pycnidium.

pycniospore (pycnospore) Minute, haploid spore formed in a pycnium by certain fungi of the Uredinales; a pycniospore functions as a male gamete.

pycnium Fungal structure formed by certain members of the Uredinales; pycnia are frequently flask-shaped and contain minute spores called pycniospores.

pycnocline Zone in the oceans where water density increases rapidly with depth in response to changes in temperature and salinity. The pycnocline tends to coincide with the thermocline and halocline, and separates the surface-water zone of ocean waters from the deep bottom water.

Pycnonotidae (bulbuls, greenbuls; order Passeriformes) Family of medium-sized, grey, brown, and olive birds, which have areas of yellow, red, white, or black. They have short to medium-length, slender, slightly curved bills, hooked or notched in some species, with rounded wings, and fairly long tails. They have rictal bristles, and hair-like neck feathers, and some are crested. They are mainly arboreal, inhabit forests and cultivated areas, feed on fruit and insects, and nest in trees and on the ground. There are 15 genera, comprising about 120 species, found in Africa, S. Asia, the Philippines, and the Moluccas.

Pycnonotus (bulbuls; family Pycnonotidae) Genus of olive, grey, and brown birds, some of which are crested, and many of which have white-tipped tails. They are popular as cagebirds. *P. jocosus* (red-whiskered bulbul) has become successfully established in Australia and N. America. It inhabits more open areas and cultivated land. There are 48 species, found naturally in Africa and Asia.

Pycnonotus jocosus (red-whiskered bulbul) *See Pycnonotus.*

pycnospore *See* pycniospore.

Pygasteroida (class Echinoidea) Small order of irregular echinoids with the periproct in a distinct posterior groove, but still partially or wholly surrounded by the apical system. They are found in Jurassic and Cretaceous strata.

Pygathrix nemaeus (Douc langur) *See* Cercopithecidae.

Pygidicranidae (earwigs; class Insecta, order Dermaptera) Family comprising the most primitive of living earwigs, which are winged, are about 1–3.5 cm long, and have long antennae. There are two subfamilies, both of which are found in Australia.

pygidium The terminal segment of an insect; the sclerites which surround the anus. *See also* Cerapachyinae.

pygmy locusts *See* Tetrigidae.

pygmy mole crickets *See* Tridactylidae.

pygmy owls *See Glaucidium.*

pygmy parrots *See Micropsitta.*

pygmy right whale (*Caperea*) *See* Balaenidae.

pygmy sperm whale (*Kogia breviceps*) *See* Physeteridae.

pygmy tits (*Psaltria*) *See* Aegithalidae.

Pygopodidae (snake lizards; order Squamata, suborder Sauria (Lacertilia)) Family of lizards, related to the geckos, which lack forelimbs and in which the hind-limbs are reduced to scaly appendages. The eye has a vertical pupil and spectacle. The body is slender, with a long tail that can be autotomized. Snake lizards may mimic snake behaviour (hissing, striking, etc.). There are 13 species, occurring in Australia and Papua New Guinea.

pyinma *See Lagerstroemia.*

pyogenic Forming, or leading to the formation of, pus.

Pyralidae (order Lepidoptera) Very large family of small to large moths, in which the structure and colour vary extensively. The hind legs are generally long. The larvae are found in terrestrial and aquatic habitats. Many are pests of crops and dried vegetable products. Distribution is wide, but the family is absent from New Zealand.

pyramidal peak *See* horn.

pyramidal tract One of the two masses of nerve fibres running longitudinally and connecting the medulla with the two parts of the cerebellum.

pyramid of biomass Diagrammatic expression of biomass at different trophic levels in an ecosystem, usually plotted as dry matter or calorific value per unit area or volume. Typically this gives a gradually sloping pyramid, except where the sizes of organisms vary dramatically from one trophic level to another. In this case, the higher metabolic rate of the smaller organisms may result in a greater biomass of consumers than of producers, giving an inverted pyramid. Aquatic communities in winter typically show inverted biomass pyramids. *Compare* pyramid of energy; and pyramid of numbers; *see also* ecological pyramid.

pyramid of energy Diagrammatic expression of the rates of flow of energy through the different trophic levels of an ecosystem. It reflects the rates of photosynthesis, respiration, etc. (and not the standing crop as in the pyramid of biomass), and can never be inverted since energy is dissipated through the ecosystem. It is the most fundamental and most useful of the three ecological pyramids. *Compare* pyramid of biomass; and pyramid of numbers; *see also* ecological pyramid.

pyramid of numbers Diagrammatic expression of the numbers of individual organisms present at each trophic level of an ecosystem. It is the least useful of the three types of ecological pyramid since it makes no allowance for the different sizes and metabolic rates of organisms. Typically it slopes more steeply than the other pyramids and may be

inverted, e.g. when based on studies of temperate woodlands in summer. *Compare* pyramid of biomass; and pyramid of energy; *see also* ecological pyramid.

Pyrenomycetes (subdivision Ascomycotina) Class of fungi which typically form ascocarps called perithecia. Asci are unitunicate and are arranged in a layer (the hymenium). There are four orders. They are saprotrophic in a wide range of habitats, or parasites in higher plants.

Pyrenulaceae (order Pyrenulales) Family of lichens in which the thallus is crustose and the ascocarps are perithecia. The asci are bitunicate. Spores are septate and colourless or brown. There are several genera, including *Pyrenula*. *P. nitida* is common on trees in moist western districts of Britain. The thallus is smooth, and green to yellowish-grey, typically surrounded and intersected by black lines. The perithecia appear as black dots up to 1 mm across.

pyrethrum Insecticide derived from the flower heads of *Chrysanthemum cinerariaefolium*, which acts as a contact poison.

Pyrgomorphidae (spear-headed grasshoppers; order Orthoptera, suborder Ensifera, superfamily Acridoidea) Family of slender, medium-sized, mainly tropical, short-horned grasshoppers, which may be winged or wingless, and cryptically or brightly coloured; they are characterized by having a conical head and a raised process on the prosternum.

Pyricularia (class Hyphomycetes) Form-genus of plant-parasitic fungi which are responsible for some important diseases of cereals and other grasses in the tropics. *P. oryzae* causes the very destructive blast disease of rice.

pyriform Pear-shaped.

pyrimidine Basic, six-membered heterocyclic compound. The principal pyrimidines—uracil, thymine, and cytosine—are important constituents of nucleic acids. Thiamine (vitamin B_1) is an important pyrimidine derivative, and other derivatives play major roles in carbohydrate and lipid metabolism.

pyrite (fool's gold) Mineral, specific gravity 4.9–5.2, hardness 6.0–6.5, chemical composition FeS_2, whose name is derived from the Greek for 'fire', referring to the spark made when it is struck. It is a very widely distributed sulphide mineral, occurring in a great variety of environments. It is found in igneous rocks as an accessory mineral; in sedimentary rocks, especially black shales; and as nodules in metamorphic rocks. It is common in hydrothermal veins, in replacement deposits, and in contact metamorphic rocks. It is distinguished by its colour, lack of tarnish, and its alteration to iron sulphate and limonite. It is pale brass-yellow, and has a greenish-black streak, and a metallic lustre. It crystallizes in the cubic system. The crystals can be cubes, pyritohedra (pentagonal dodecahedra), octahedra, or combinations of the two. It was formerly used widely for the production of sulphuric acid.

pyrochlore Mineral, specific gravity 4.2–6.4, hardness 5.0–5.5, and with the chemical composition $(Ca,Na)_2(Nb,Ta)_2O_6(O,OH,F)$, whose name is derived from Greek and refers to its green colour when heated. It is found in granitic rocks and pegmatites, with or near alkaline rocks, and in association with zircon, apatite, and also carbonatites. Its characteristic feature is its crystal form. It is normally brown to black with a light brown streak, and has a vitreous to greasy lustre. It crystallizes in the cubic system. The crystals are usually octahedra or irregularly shaped grains. The calcium and sodium in the crystal lattice can be substituted with uranium, thorium, or the rare earth elements. It is an ore for niobium, tantalum, and the rare earths.

Pyrochroa (cardinal beetles) *See* Pyrochroidae.

Pyrochroidae (cardinal beetles; class Insecta, order Coleoptera) Family of soft-bodied, pubescent beetles, up to 17 mm long, which are often partly scarlet. The antennae are long, and filiform to pectinate. The beetles are found under bark or feeding at flowers. Larvae have an elongate, toughened body, the terminal segment with a pair of backward-pointing spines. The legs are well developed. Cardinal beetles live under bark; *Pyrochroa coccinea* larvae inhabit dead oak trees, while *P. serraticornis* seems to prefer elm. There are 116 species.

pyroclastic Applied to volcanic rocks consisting of fragmented particles, generally produced by explosive action.

pyroclimax *See* fire climax.

Pyrolaceae Family of dicotyledonous, evergreen herbs, with creeping rhizomes bearing simple, stalked leaves. The family is close to Ericaceae, but differs in having petals that are always free, minute seeds, an ovary incompletely divided into five cells, and the herbaceous habit. There are four genera, comprising some 35 species, confined to the northern temperate and arctic zones, where they usually occur in coniferous forests or on heathland, etc., growing in the vegetable litter layer which they exploit as partial saprophytes by means of a mycorrhizal relationship with a fungus.

pyrolusite Mineral, specific gravity 4.5–5.0, hardness 5.0–6.0 for crystals which decreases to 2.0 when it is massive, chemical composition MnO_2, whose name is derived from the Greek for 'fire' and which is a common manganese mineral. It is a secondary mineral found in the oxidized zone of manganese deposits. It can also occur in quartz veins, and as nodules on the sea-bed. It is distinguished by its colour and softness when massive. It is black to bluish-grey, and has a black streak, and a metallic lustre. It crystallizes in the tetragonal system. The rare crystals are acicular and rod-like, but it is usually massive, cryptocrystalline, and dendritic on joints and bedding planes. It is used for dry batteries, as a decolorizer for glass, and in the manufacture of chemicals.

pyromorphite Mineral, specific gravity 6.5–7.1, hardness 3.5–4.0, and with the chemical composition $Pb_5(PO_4)_3Cl$, whose name is derived from

Greek and means 'fire form'. It is a secondary mineral occurring in the oxidized zones of veins containing lead minerals, often associated with mimetite and anglesite, and galena. Its most distinguishing features are its colour, hexagonal form, and high specific gravity. It can be various shades of green, yellow, and brown, and has a white streak and a vitreous lustre. It crystallizes in the hexagonal system. The crystals are usually of a simple prismatic form, but they can often be barrel-shaped (campylite) or fibrous, granular, and globular.

pyrope Mineral, specific gravity 3.51, hardness 6.0–7.5, and with the chemical composition $Mg_3Al_2(SiO_4)_3$, whose name is derived from Greek and means 'fire-like'. It is a widely distributed member of the garnet family, found in metamorphic and igneous rocks, and in alluvial deposits. It is dark red, pink-red, or black, and has a vitreous lustre. It crystallizes in the cubic system. The crystals form rhombododecahedra, and it is also massive. Fine crystals are used as gemstones.

Pyrophorus (firefly) *See* Elateridae.

pyrophyte Plant adapted to withstand or to achieve a competitive advantage from fire, e.g. *Themeda triandra*, a grass widespread in Kenyan savannahs.

Pyrotheria (infraclass Eutheria, cohort Ferungulata, superorder Paenungulata) Extinct order of elephant-like ungulates which lived in S. America during the Oligocene. They were the size of modern elephants, had trunks and chisel-like tusks developed from the incisors, and their molar teeth were similar to those of early proboscideans. The skull and skeleton were also similar to that of elephants. They arose independently of the true elephants, from an early ungulate stock apparently confined to S. America, and their resemblance to elephants arises from convergence.

pyroxene An extensive group of minerals which are widely distributed in both igneous and metamorphic rocks. They are divided into two sub-groups: those in the monoclinic system, and a smaller number in the orthorhombic system. They are classified as being single-silicate-chain structures. The colours are variable, but usually dark greens, browns, or black, and they have a vitreous lustre. Their specific gravity is about 3.0–3.5, their hardness 5.0–6.0. Iron and magnesium are the main metals joined to the chains, with calcium, sodium, aluminium, and lithium in different combinations in the lattice. The crystals are usually short or columnar prisms which show well marked cleavages. All the minerals are rock-forming.

Pyrrhocoridae (order Hemiptera, suborder Heteroptera) Small family of plant-feeding bugs which are mainly associated with tropical plants, especially those of the family Malvaceae. *Dysdercus* (cotton stainers) damage cotton bolls in the fields. *Pyrrhocoris apterus* (firebug) lives on mallows, hollyhocks, and lime trees in Europe.

Pyrrhocoris apterus (firebug) *See* Pyrrhocoridae.

Pyrrhosoma nymphula (large red damselfly; order Odonata, suborder Zygopotera, family Coenagrionidae) Species of striking, red damselflies which have prominent red humeral stripes. Females are larger than males, and have more black on the abdomen. They are often the first of the odonates to appear in the spring. They occur in a wide variety of habitats in Europe and Asia Minor.

pyrrhotine (magnetic pyrite) Mineral, specific gravity 4.6–4.7, hardness 3.5–4.5, chemical composition FeS, whose name is derived from the Greek for 'reddish'. It occurs in igneous rocks, e.g. gabbro or norite, as disseminated grains, and also in metamorphic contact zones in association with chalcopyrite and pyrite. It is distinguished by its reddish-brown colour and its magnetism: it is one of the few common minerals to exhibit magnetism. It is bronze-yellow but darkens rapidly to reddish-brown on exposure, and has a greyish-black streak, and a metallic lustre. It crystallizes in the hexagonal system. Crystals are rare, and can be platy or tabular; the mineral is usually massive or granular. Pyrrhotine was used formerly for the production of sulphuric acid.

Pyrrhula (bullfinches; family Fringillidae) Genus of grey, red, orange, and brown birds which have black tails and wings, and white rumps. Most have a black face or black cap. Their bills are short and stout. They inhabit woodland; feed on berries, seeds, and buds; and nest in trees. There are six species, found in Europe, Asia, and the Azores.

Pyrrhura (conures; family Psittacidae) Genus of medium-sized, mainly green parrots which have blue primaries, and a head coloured with grey, blue, yellow, red, and white. They have long, gradated tails. They inhabit forests; feed on seeds, fruit, nuts, and blossoms; and nest in tree holes. There are 18 species, found in C. and S. America, and many are kept in captivity.

Pyrus (pears; family Rosaceae) Genus of deciduous, sometimes thorny trees and shrubs, with simple leaves, and flowers borne in umbel-like clusters. There are five sepals, five petals, 20–30 purple stamens, and 2–5 carpels fused together and with the receptacle, though the styles are separate. The flesh of the pear-shaped fruits contains numerous woody, grit-like cells, unlike that of apples (*Malus*). Many cultivars are grown for their fruits. There are about 20 species, occurring in northern temperate Eurasia.

pyruvic acid Three-carbon keto acid that occupies a central position in cell metabolism. It represents the final product of glycolysis in aerobic respiration: it subsequently undergoes oxidation to carbon dioxide and acetyl coenzyme A. During anaerobic respiration it is reversibly converted to lactic acid in animal cells and irreversibly to ethyl alcohol in those of plants. It may also be variously converted into alanine, malic acid, and oxaloacetic acid.

Pythiaceae (order Peronosporales) Family of fungi, which are saprotrophic in soil and water. Some can live also as parasites on plants or, in one genus, on rotifers. The family contains six genera.

Pythium (family Pythiaceae) Genus of fungi, most of which are saprotrophs in soil or water. Under certain conditions they may cause certain plant diseases, including stem and root rots and damping-off in seedlings. There are about 92 species.

Python reticulatus (reticulated python; order Squamata, suborder Serpentes (Ophidia), family Boidae) Snake similar in size to the anaconda, the largest authentic record being 8.5 m long. It is often found near water, sometimes swimming out to sea. Its prey consists mainly of mammals and birds, which it kills by constriction. It occurs in the Indo-Malaysian region.

pythons *See* Boidae; and *Python reticulatus*.

Q

Q_{10} The ratio of the velocity of a reaction at a given temperature to that of the same reaction at a temperature by 10 °C lower. This ratio is approximately 2.0 for most biological reactions.

Q fever Acute disease caused by *Coxiella burnetii*. A wide range of animals can be infected, including domestic livestock; humans are commonly infected from domestic animals e.g. via contaminated milk or on inhalation of contaminated dust. Symptoms are typically respiratory, with fever, headache, and prostration; the disease is rarely fatal.

QO_2 *See* oxygen quotient.

Q technique Method for analysing data, in which observations (N) form the columns and the variables or attributes (n) form the rows in a table or matrix. *Compare* R technique; *see also* inverse analysis; and normal analysis.

quadrat Basic sampling unit of vegetation surveys. Traditionally 1 m^2 quadrats were used to sample short, non-woody communities such as grasslands and heathlands. More recently circular and rectangular quadrats have been used as well as squares of all sizes depending on the purpose of the survey, e.g. 10 m^2 and 20 m^2 quadrats are commonly used in woodland studies.

quadrate In Gnathostomata other than Mammalia, the posterior cartilage-bone of the upper jaw, attached to the braincase and articulating with the lower jaw. In mammals it forms the incus of the inner ear.

quadritubercular Applied to a molar tooth with four cusps.

quadrupedal Applied to animals that walk on four feet.

quail doves *See Geotrygon*.

quails 1 *See* Phasianidae. 2 (wood quails) *See Odontophorus*.

qualitative inheritance Inheritance of a character that differs markedly in its expression amongst individuals of a species: variation in that species is discontinuous. Such characters are usually under the control of major genes. A principal example is gender. *Compare* quantitative inheritance.

quantasome Particle, approximately 1.8 nm long, embedded in a paracrystalline array on the surface of thylakoid discs in chloroplasts. Quantasomes are composed equally of lipids and proteins, which include various photosynthetic pigments and redox carriers. For this reason they are considered to be the centre of the light reaction in photosynthesis.

quantitative character *See* quantitative inheritance.

quantitative inheritance Inheritance of a character that depends upon the cumulative action of many genes, each of which produces only a small effect. Examples of such quantitative characters include clutch size in birds, milk production in cattle, and weight and skin pigmentation in humans. Usually the character shows continuous variation, i.e. a gradation from one extreme to the other. *Compare* qualitative inheritance.

quantum evolution Sudden spurt of diversification in an evolutionary lineage. Typically it results when a population shifts into another adaptive zone. Initially the number of individuals will be small and rapid genetic and phenotypic change is feasible in such circumstances, particularly if the new niche is unoccupied. The concept of quantum evolution has been given special significance in the theory of punctuated equilibrium.

quantum speciation Traditionally, the rapid speciation that can occur in small populations isolated from the large, ancestral population, and that are therefore subject to the founder effect and to genetic drift. More recently the term has been assigned a central role in the theory of punctuated equilibrium.

quartz (amethyst, citrine, cairngorm) One of the most widely distributed rock-forming minerals, specific gravity 2.65, hardness 7.0, chemical composition SiO_2. It is found in many igneous and metamorphic rocks, and extensively in clastic rocks. It is a common gangue mineral found in mineral veins. It is distinguished by its crystal form, lustre, conchoidal fracture, and hardness. It is commonly colourless or white, but can occur in a variety of colours, and it has a vitreous lustre. It crystallizes in the trigonal system. The crystals are usually six-sided prisms terminated by six-faced pyramids, and the prisms are often striated. It also occurs extensively in massive form. Amethyst is quartz with a distinct purple colour; citrine is yellow quartz, transparent and resembling topaz; cairngorm is a brown or nearly black variety.

quartz sandstone *See* arenaceous.

quasi-equilibrium *See* equilibrium.

quasi-sympatric speciation Separation of one species into two by adaptation of different subpopulations into different niches.

Quaternary Period of geological time that covers the last 1.8 million years approximately. The Quaternary comprises the Pleistocene and Holocene Epochs and is noted for numerous major ice-sheet advances in the northern hemisphere. By the Pleistocene most of the faunas and floras had a modern appearance. The Quaternary is often termed 'the Age of Man'.

quaternary structure The structure of a protein that results from the interaction of two or more individual polypeptides to give larger functional molecules. *Compare* primary structure; secondary structure; and tertiary structure.

queen In a colony of social insects, the primary female reproductive.

Queensland arrowroot (*Canna edulis*) *See Canna*.

Queensland grouper (*Promicrops lanceolatus*) *See* Serranidae.

Queensland halibut (*Psettodes erumei*) *See* Psettodidae.

Queensland maple *See Flindersia*.

Queensland nut *See Macadamia*.

Quelea quelea (red-billed quelea) *See* Ploceidae.

Quercus (oak; family Fagaceae) Genus of deciduous and evergreen trees and shrubs of the beech family. The wood has distinctive, broad, compound rays. The buds are scaly. The leaves have small stipules, and are entire, toothed or rarely crenate. Male flowers are borne in catkins, female flowers are solitary. The fruit is one nut seated in a woody cupule, the acorn. Many species are important for timber, tanning (the bark), cork (*Q. suber*), or as ornamentals. There are about 500 species, found in the northern-hemisphere temperate zone, subtropical and tropical Asia, and the Andes.

quetzal *See* Trogonidae.

Quetzalcoatlus northropi A huge pterosaur, first discovered in 1975 in Texas. It had a wingspan of 10 m or more and lived as do vultures, using warm air thermals to soar high over the Cretaceous plains.

quinine Alkaloid formerly much used in the treatment of malaria; it is obtained from the bark of the *Cinchona* tree. Quinine has now largely been replaced by more modern drugs.

quinone *p*-dioxybenzene or a derivative thereof; many quinones act as electron carriers in mitochondria and chloroplasts.

quinsy Advanced stage of tonsillitis in which abscesses develop around the tonsils. The causal agent is a bacterium, usually *Streptococcus pyogenes*.

Quisqualis *See* Combretaceae.

R

rabbit *See* Leporidae.

rabbitfish (*Chimaera monstrosa*) *See* Chimaeridae; and Siganidae.

rabies Disease which affects mainly terrestrial carnivores, although almost any homoiothermic animal can be infected. Symptoms vary among animals. In dogs and humans there is initially an excited stage with excessive salivation, and this is followed by depression, hydrophobia and paralysis. It is almost always fatal in all species. The disease is usually transmitted by bites; saliva of infected animals is highly infectious. It is caused by a rhabdovirus.

raccoon (*Procyon lotor*) *See* Procyonidae.

raccoon dog (*Nyctereutes procyonoides*) *See* Canidae.

race Interbreeding group of individuals all of whom are genetically distinct from the members of other such groups of the same species. Usually these groups are geographically isolated from one another, so there are barriers to gene flow. Examples are island races of birds and mammals, such as the Skomer vole and the St Kilda wren.

raceme In flowers, an inflorescence in which the main axis continues to grow, producing flowers laterally, such that the youngest ones are apical, or at the centre. Growth is monopodial. *Compare* corymb.

rachis In a plant, the axis that bears the flower, or, if the plant has compound leaves, the leaflets. *See also* pinnate.

Rachycentridae (cobia, black kingfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine fish, including only *Rachycentron canadum* (cobia), 1.6 m. It has an elongate body, a deeply forked tail, and long-based but low second dorsal and anal fins, the first dorsal fin being reduced to a series of isolated spines. The cobia is a powerful and highly regarded gamefish, usually swimming alone rather than in schools. Probably it is distributed worldwide in warmer seas.

racial senescence *See* phylogerontism.

Racomitrium (order Grimmiales) Genus of medium to large mosses, in which the archegonia (and hence capsules) are borne terminally on short, lateral branches. Stems are erect or prostrate, often with numerous short branches. It is a cosmopolitan genus, with about 80 species. Most are saxicolous, mainly on acidic rocks. *R. aciculare* grows on acidic rocks near or in water. *R. aquaticum* grows mainly on wet acidic rocks and on ledges in mountainous regions, often near flowing water. *R. lanuginosum* grows on exposed mountain tops on rock or on peat, often forming extensive mats and giving its name to the plant community of this habitat: *Racomitrium* heath (formerly *Rhacomitrium* heath). In this species each leaf has a long hair point (often as long as the leaf itself), which is rough with minute teeth; the plant has a characteristic grey-green colour, and the shoots appear hoary because of the white massed hair points.

racquet organ In Solifugae, a sensory organ on the ventral surface of the fourth pair of legs, somewhat resembling a tennis racquet.

radar tracking Observational technique, used in field studies of animal behaviour, in which subjects are tracked by radar. By watching a plan-position indicator or from time-lapse photography of the screen, information can be obtained about the movements of birds and insects. Birds fitted with metal tags can be distinguished from untagged birds because of the stronger echo returned by the tags.

radial drainage Drainage pattern consisting of streams that extend radially from a central zone. It is typical of the patterns developed on freshly constructed land-forms (e.g. volcanoes) and on areas of domed uplift.

radial shield *See* Gnathophiurina; and Phrynophiurida.

radiation budget (energy budget) The difference between the amount of incoming solar radiation and the amount of outgoing terrestrial radiation. The balance is in deficit (i.e. more energy leaves the Earth's surface than reaches it from the Sun) at night. Overall, the highest positive net balance is found in low latitudes.

radiation ecology The branch of ecology concerned with the effects of radioactive materials on living systems and on the pathways by which they are dispersed through ecosystems, including their dispersal through the abiotic environment. The term is used especially with regard to those materials released through human agency.

radiation fog Condensation effect over land surfaces on clear nights with light breezes, due to surface radiation cooling. Favoured initial conditions are very humid air, with wet and cold surfaces, e.g. marshes. The fog, most common in winter, is generally cleared by the Sun's warmth in the morning, but thick fog over wet surfaces in winter may persist much longer, particularly if an upper cloud layer screens the Sun.

radiation inversion Temperature inversion in the lower atmosphere due to radiation cooling of the ground at night. *See also* radiation night.

radiation night A night with clear skies, when terrestrial long-wave radiation cannot be partly

returned to the surface by cloud. There is rapid cooling of the air close to the ground, particularly when there is little wind, giving low minimum surface temperatures.

radiatus From the Latin *radiatus* meaning 'with rays', a variety of cloud with parallel bands which, due to perspective, appear to meet at the horizon. The effect is seen in cumulus, stratocumulus, altocumulus, altostratus, and cirrus. *See also* cloud classification.

radioactive decay Process by which a radioactive 'parent' element loses elementary particles from its nucleus and in doing so becomes a stable 'daughter' element. The rate of decay is constant for a given element and is a very precise and accurate device for the measurement of geological time.

radioactive tracer Radioactive isotope, whose movement can be monitored, that is used to trace the pathways by which individual substances move through an organism, a living system, the abiotic environment, etc. Non-radioactive chemical analogues of certain substances may be used for the same purpose if their movement can be monitored, e.g. caesium, which can be substituted for potassium.

radio-carbon dating (^{14}C dating) A dating method for organic material that is applicable to about the last 70 000 years. It relies on the assumed constancy over time of atmospheric $^{14}C : {}^{12}C$ ratios (now known not to be valid), and the known rate of decay of radioactive carbon, of which half is lost in a period—the 'half-life'—of every 5730 years ± 30 years. (The earlier 'Libby standard', 5568 years, is still widely used.) In principle, since plants and animals exchange carbon dioxide with the atmosphere constantly, the ^{14}C content of their bodies when alive is a function of the radiocarbon content of the atmosphere. When an organism dies, this exchange ceases and the radiocarbon fixed in the organism decays at the known half-life rate. Comparison of residual ^{14}C activity in fossil organic material with modern standards enables the calculation of the age of the samples. Since the method was first devised it has been realized that the atmospheric ^{14}C content varies, as the cosmic-ray bombardment of the outer atmosphere that generates the ^{14}C varies. Correction for these fluctuations is possible for about the last 8000 years by reference to the ^{14}C contents of long tree-ring series, e.g. those for bristlecone pine.

Radiolaria (class Actinopodea) Subclass of protozoa which possess more or less elaborate skeletons of silica. The cell body is generally spherical with axopodia radiating from the periphery. Many species are known. They are chiefly pelagic marine organisms. Fossil radiolarians have been found in Precambrian rocks and they are important stratigraphic fossils for Mesozoic and Cenozoic deep-sea sediments.

radiolarian ooze Deep-sea ooze in which at least 30% of the sediment consists of the siliceous radiolarian tests. Radiolarian-rich oozes occur in the equatorial regions of the Pacific and Indian Oceans where the depth exceeds the carbonate-compensation depth—around 4500 m in the central Pacific.

radiometric dating (radioactive dating) The most precise method of dating rocks, in which the relative percentages of 'parent' and 'daughter' isotopes of a given radioactive element are estimated. Early methods relied on uranium and thorium minerals, but potassium/argon, rubidium/strontium, and carbon 14 are now of considerable importance. Of these the uranium 238/lead 206 parent and daughter isotopes have a half-life of 4.5 billion (10^9) years, rubidium 87/strontium 87 a half-life of 50.0 billion years, and potassium 40/argon 40 one of 1.5 billion years. For carbon 14 the half-life is a mere 5730 ± 30 years (*see* radiocarbon dating), and beyond about 70 000 years the amount of carbon 14 remaining in organic matter is beyond accurate measurement.

radiosonde Instrument, comprising an aneroid barometer and sensors for temperature and humidity, that is carried aloft to the upper atmosphere by a balloon that ascends at about 5 m/s. Data is transmitted to the surface by radio. *See also* rawinsonde.

radio tracking Observational technique used in field studies of animal behaviour, in which the animal is fitted with a battery-powered fixed-frequency radio transmitter, usually attached to a collar, and the observer is equipped with a receiver and directional antenna.

radius In tetrapods, the pre-axial bone of the forelimb.

radula In most Mollusca, a chitinous strip, constantly renewed, with rows of teeth transversely across its surface, located on the floor of the buccal cavity and used for rasping food.

raffia (bast, bass) Fibrous tissue from the upper sides of young leaflets of the palm *Raphia vinifera*. *See Raphia*.

Rafflesia (family Rafflesiaceae) Genus of plants which are wholly parasitic on vines of the Vitaceae. The flowers are showy and huge (up to 1 m diameter in *R. arnoldii*). They have 4–6 fleshy tepals, fused at the base; stamens fused as a ring; and the ovary inferior and immersed in a central column, smelling of carrion, and fly-pollinated. It is a prized medicine. There are 12 species occurring in W. Malaysia.

Rafflesiaceae Family of plants which are parasites. The vegetative tissues are colourless, mycelium-like, and immersed in the host. The flowers are often large. There are nine genera, with 50 species, occurring in the tropics and subtropics.

ragfish (*Icosteus aenigmaticus*) *See* Icelidae.

ragworts *See Senecio*; and Compositae.

rail-babbler *See Eupetes*.

rails *See Crex*; *Fulica*; *Porzana*; and Rallidae.

rainbow Phenomenon in which an arc of colours of the spectrum results from the refraction of the Sun's rays by water droplets in the atmosphere. A

primary bow is seen at a limiting angle of 42° from the observer's shadow. A secondary bow, at 51°, may occur; as can multiple bows due to some light being reflected within the raindrops before refraction. The colour separation in the primary bow produces a spectrum with red on the outer edge. The colours are reversed in the secondary (outer) bow. The colour and intensity vary with the size of raindrops, large drops producing bright colours dominated by red.

rainbowfish *See* Melanotaeniidae.

rainbow runner (*Elagatis bipinnulatus*) *See* Carangidae.

rainbow trout (*Salmo gairdneri*) *See* Salmonidae.

raindrop Droplet of water larger than a cloud droplet, i.e. more than 0.2 mm in diameter.

rain frog *See Breviceps adspersus*.

rain-gauge Device, usually of copper or polyester, used for gathering rain. A tapering funnel of standard dimension allows the water to collect in an enclosed bottle or cylinder for subsequent measurement. The gauge is set in open ground with the funnel rim up to 30 cm above the ground surface. Some gauges are self-reading.

rain-making Attempt to induce rainfall by 'seeding' supercooled water clouds. *See also* cloud seeding.

rain-shadow The reduction of rainfall to the lee side of a mountain barrier, which produces relatively dry surface conditions, e.g. in the mountains of the SW USA, where the wetter western slopes of the Coast Range and Sierra Nevada contrast with the desert areas of Nevada and E. California on the lee side of the mountains.

raised beach Former beach, now found above the level of the present shoreline as a result of earth movement or of a general fall in sea-level. Such beaches are frequently described and correlated in terms of height above present sea-level.

raised bog Ombrogenous bog community. Typically it is dome-shaped in section, developing on former lake sediments, uniform clay substrates, and sometimes on valley-bog surfaces. In the British Isles, living (i.e. still growing upward) raised bogs are confined to western oceanic areas, most notably central Ireland. The living bog surface shows a complex of hummocks and pools (the regeneration complex) with different *Sphagnum* species occupying different positions in relation to the degree of waterlogging. Hummocks typically are colonized by wet heath species, e.g. 'heathers' (*Calluna vulgaris* and *Erica tetralix*) and 'sedges' (e.g. *Eriophorium* species). *See also* bog; and ombrogenous peat; *compare* blanket bog; and valley bog.

Raja radiata (starry ray) *See* Rajidae.

rajah butterflies *See* Nymphalidae.

Rajidae (skate, thornback ray; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Large family of marine rays characterized by a relatively short tail with one or two dorsal fins, and ending in a blunt tip without a caudal fin. The wide body or disc is angular in shape, often showing a pointed snout or rostrum. Male skates usually show enlarged denticles on the dorsal surface (thorny back). *Raja radiata* (starry ray), 60 cm. of the N. Atlantic, and the other skates reproduce by laying eggs encased in rectangular, horny capsules, which are sometimes found among the flotsam on the beach. There are about 120 species, distributed worldwide.

Rajiformes (rays) Order of mostly marine fish, which differ from sharks in having a strongly depressed body, with the gill openings on the ventral (belly) side and the eyes located on top of the head. The eight families comprising the order include, for example, the Rajidae and Dasyatidae.

Rallidae (rails, coots, gallinules; order Gruiformes) Family of small to medium-sized birds which have black, olive, chestnut, or buff plumage, some being barred or spotted. They have laterally compressed bodies; short, rounded wings; short tails; and medium to long legs with long toes. The bill is short and conical to long and decurved, and some bills have frontal shields. Rallidae are secretive, terrestrial, and often aquatic: most live in marshes, feed on animal and vegetable matter, and nest on the ground or low in a bush. There are 30–40 genera, with about 125 species, some migratory, found worldwide.

Ramalinaceae (order Lecanorales) Family of lichens in which the thallus is fruticose, typically flattened but occasionally round in cross-section, and erect to pendulous. Apothecia are typically borne on the edges of the thallus. Spores are mono-septate, colourless, and often curved. There are several genera, found on bark and on non-calcareous rocks, mainly in warmer regions.

Ramapithecus Late Miocene and early Pliocene ape, known from fragmentary fossils from E. Africa, SE Europe, and N. India and Pakistan, 10–14 million years ago, and apparently identical or very similar to the E. African *Kenyapithecus*. *Ramapithecus* is regarded by many as transitional between the true Miocene apes (the Dryopithecinae) and the later Hominidae. If this is so, then the human and ape lines diverged prior to the late Miocene, 15–25 million years ago. More recent evidence, however, suggests that *Ramapithecus* and the related or identical *Sivapithecus* are nearer to the evolutionary line that led to the orang-utan.

Ramaria (family Clavariaeae) Genus of fungi, characterized by their richly-branched, coralloid fruit bodies, which have tough flesh, and by their yellow to brown spores which are typically rough-surfaced. They are found mostly on the ground; *R. stricta* grows on tree-stumps.

rambutan *See Nephelium*.

ramet Individual member of a clone. The term may be used at different levels, e.g. a leaf of the clover, or the individual strawberry plant.

ramie (*Boehmeria nivea tenacissima*) *See Boehmeria*.

ramiflorous Borne on the branches.

ramin *See Gonystylus*.

Ramphastidae (toucans; order Piciformes) Family of medium sized to large birds which have brightly coloured and contrasting black, white, red, yellow, green, and blue plumage. They have very large, deep bills coloured black, red, and yellow, with bare skin around the eyes. Their wings are short and rounded, their tails usually long, and their legs strong, with zygodactylous feet. They are gregarious; inhabit forests; feed on fruit, insects, and young birds; and nest in tree holes. There are six genera, with about 40 species, found in C. and S. America.

ramus A branch; a projection from a bone. In some Crustacea, one of the branches of a limb.

Rana catesbiana (American bullfrog; order Anura (Salientia), family Ranidae) Frog, up to 20 cm long, the male of which has paired vocal sacs, a loud voice, and a tympanum larger than its eye. Essentially it is aquatic. Its prey includes other frogs, young alligators, snakes, birds, and small mammals. It is native to the eastern USA and has been introduced into some western states, Canada, Hawaii, and Cuba.

Rana esculenta (edible frog; order Anura (Salientia), family Ranidae) Frog in which the snout is pointed, the body slim, and the legs long. It is green to brown in colour, with a yellow-green mid-dorsal stripe. Males grow to 7.5 cm long, females to 9 cm, and occasionally larger. They are generally found in or close to water. The species is native to W. Europe, and has been introduced into S. England, where it is now rare.

Rana pipiens (leopard frog, meadow frog; order Anura (Salientia), family Ranidae) Frog, in which the head is pointed, and the body slender. It grows up to 10 cm long, and is greenish-brown with rows of black, brown, or green spots, ringed with a lighter colour. It is usually found near water. It is common throughout S. Canada, USA, and much of C. America.

Rana ridibunda (marsh frog, laughing frog; order Anura (Salientia), family Ranidae) An essentially aquatic frog whose diet includes small birds and mammals. It is the largest European frog (up to 17 cm long). Its range extends into N. Africa and W. Asia. There is a colony in SE England resulting from an introduction in 1935.

Rana temporaria (common frog, European frog; order Anura (Salientia), family Ranidae) A brownish frog, which has a dark triangle around the eardrum. The male has blue blotches on throat and back; the female has yellow and red sides. It is distributed in Britain but not Ireland, through NW and C. Europe, into the USSR.

random assortment *See* independent assortment.

random genetic drift *See* genetic drift.

random sample Sample in which each individual measured or recorded (e.g. organism, site, or quadrat) is independent of all other individuals and also independent of prominent features of the area or other unit being sampled. In ecological field surveying, random quadrat sampling is most easily achieved by superimposing a grid over the sample area, and identifying a series of random co-ordinates, using random-number tables, at which to locate the quadrats. Alternatively, a random-walk technique may be used.

random-walk technique Method of random sampling in which the direction taken and the distance moved between sample points is determined by random numbers, drawn most usually from random-number tables.

range 1 The spread of environmental conditions within which a particular species occurs. 2 Extensive, open grazing lands.

range management The use of extensive, open grasslands for cattle production or, where appropriate, for the exploitation for human use of semi-domesticated or wild grazing animals (e.g. game cropping on the African savannah) by methods that maintain the ecosystem. These require the determination of the optimum stocking density that will permit long-term cropping of the grassland without deterioration of the pasture.

range zone (acrozone) Unit of strata defined by the presence and time-range of a given fossil species.

Rangifer tarandus (reindeer) *See* Cervidae.

Ranidae ('true' frogs; class Amphibia, order Anura (Salientia), suborder Diplasiocoela) Diverse family of amphibians in which the skeleton is modified for jumping. The tongue always has a notched end. Males often develop vocal sacs. There are about 300 species, occurring in all continents except Antarctica; *Rana* is the only genus with a worldwide distribution, and the only genus in N. America.

Ranunculaceae Family of dicotyledons, mostly herbs but including a few shrubs, with leaves that are usually alternate, without stipules, and often palmately lobed or compound. The flowers are usually regular, with four or five to many free sepals and petals, and numerous free and spirally arranged stamens and carpels. These are all features usually regarded as 'primitive', but exceptions to most of them occur within the genera of the family. Modern classifications recognize about 48 genera, with 1300 species (e.g. *Ranunculus* (buttercups), occurring mostly in the N. temperate, arctic, and alpine zones. Most are poisonous and very acrid; some are used in medicine; others (e.g. *Delphinium* and *Anemone*) are grown for their beautiful flowers.

rape *See Brassica*.

Raphia (family Palmae) Genus of solitary or clump-forming palms, most of which are huge. The leaves are pinnate, and include the largest leaves in the world. The inflorescences are either terminal, the stem then dying, or axillary, and form as sinuous, bract-enclosed cylinders, sometimes branching, with male and female flowers. The fruits are scaly. Palm wine is obtained by tapping the inflorescences of *R. taedigera* and *R. vinifera*. There are 28 species found in Africa, and one (*R. taedigera*) in tropical America. *See* piassava; and raffia.

Raphidae (dodos, solitaires; order Columbiformes) Extinct family of large, flightless birds which had

rudimentary wings and short tails. They were grey or brown, and *Raphus cucullatus* (dodo) had a large head and a heavy, hooked bill, while *R. solitarius* (Rodriguez solitaire) had a smaller head and a lighter bill. They were terrestrial, probably fed on fruit, and nested on the ground. There were two genera, with three species, known only from the Mascarenes. They became extinct in the seventeenth and eighteenth centuries.

Raphidia notata *See* Raphidiidae.

Raphidiidae (snakeflies; subclass Pterygota, order Megaloptera) Family of predatory insects, which have four membranaceous wings with a complex venation, similar to those of lacewings and alderflies. The characteristic prolongation of the prothorax in the adults, to form a snake-like neck, gives the family its common name. Adults and larvae are usually found on or under bark where they feed on aphids and other small insects. *Raphidia notata* is one of the commonest European species. It is 25 mm long, and greyish-brown with large wings.

Raphidura *See Chaetura.*

raptors *See Falco*; Falconidae; and Falconiformes.

rare-earth element (lanthanide) One of those elements, with atomic number 57–71, that have closely similar chemical properties. The ionic radius decreases with increasing atomic number, a phenomenon referred to as the lanthanide contraction. Lanthanum (atomic number 57) is the first in the series.

Rasbora heteromorpha (harlequin) *See* Cyprinidae.

Rasbora maculata (dwarf rasbora) *See* Cyprinidae.

raspberry *See Rubus.*

raspwort *See Haloragis.*

rastellum *See* trapdoor spiders.

rat 1 (Old World) *See* Muridae. 2 (New World) *See* Cricetidae.

rat-bite fever (sodoku) Disease which may occur following the bite of a rat; the causal agent is usually either *Streptobacillus moniliformis* or *Spirillum minor*, bacteria normally present in the mouth of a rat. Symptoms include fever and prostration, and the disease may be fatal.

rat chinchilla (*Abrocoma*) *See* Abrocomidae.

ratel (honey badger, *Mellivora capensis*) *See* Mustelidae.

ratfish *See* Chimaeridae.

ratite One of many flightless, running birds which have no keel on their sternum. Struthionidae, Rheidae, Casuaridae, Dromaiidae, Apterygidae, Dinorthidae, and Aepyornithidae are all ratites.

rattan (rotan) *See Bejaudia*; *Calamus*; *Calospatha*; *Ceratolobus*; *Daemonorops*; *Korthalsia*; *Myrialepis*; *Plectocomia*; and *Plectomiopsis*.

rattlesnakes *See* Crotalidae.

Raunkiaer's life-form classification A classification of plants, proposed by the Danish botanist C. Raunkiaer, based on the position of perennating buds in relation to the soil surface. *See also* chamaeophyte; epiphyte; geophyte; hemicryptophyte; phanerophyte; and therophyte.

Rauvolfia (family Apocynaceae) Genus of shrubs or small trees, some species of which, especially *R. serpentina*, produce the alkaloid reserpine, used to counteract high blood pressure. There are 100 species, with a pantropical distribution.

Ravenala (family Strelitziaceae) Genus of one species, *R. madagascariensis* of Madagascar, which is an unbranched tree with banana-like leaves held in a plane like a huge fan. The fruit is a capsule, the seeds arillate. It is called 'traveller's palm' because of the potable water trapped by the sheathing leaf bases, and is widely cultivated.

ravens *See Corvus.*

ravine wind Wind that passes through an upland barrier along a narrow valley or ravine. The wind is generated by a pressure gradient between the two ends of the valley and the force of the wind is often enhanced as a result of the channelling effect caused by constriction in the valley.

rawinsonde Radiosonde that is tracked by radio or radar to observe wind characteristics as well as to record temperature, pressure and humidity.

ray *See* Rajiformes.

ray-finned fish *See* Actinopterygii.

Rayleigh scattering The scattering of electromagnetic radiation by spherical particles with radii that are less than 10% that of the wavelength of the incident radiation. Such scattering by air molecules produces the blue effect of the sky. Particles such as dust and smoke, with diameters significantly smaller than 0.4 μm (the blue/violet or lower limit of the visible spectrum) can also scatter visible radiation. Reddish colours at sunset and sunrise result from Rayleigh scattering, these greater wavelengths passing directly through the atmosphere to the observer when the blues and the rest have been scattered out. *See also* Mie scattering.

Ray's bream (*Brama brama*) *See* Bramidae.

razorfish *See* Centriscidae.

razor-strop fungus Common name for the fruit body of *Piptoporus betulinus*, a parasite of birch trees. The fruit body was once used for stropping razors.

R/B ratio *See* respiration–biomass ratio.

RDP *See* ribulose-1,5-diphosphate.

reaction 1 (pedol.) The degree of acidity or alkalinity of a soil, expressed as a value on the pH scale. *See also* acid soil; and alkaline soil. 2 (ecol.) In plant succession, the ability of an individual plant species or vegetation community to modify the physical environment and so favour further successional development. For example, the presence of the first colonizing plants in a hydrosere will tend to reduce water movement, favouring accelerated silting and so paving the way for plants typical of shallower water to arrive as new colonizers.

reading-frame shift (genetics) In the normal transcription of a cistron, nucleotides are read in threes, the 'reading frame' being determined by the starting-point. Each triplet codes a specific amino acid; the sequence of codons therefore dictates the amino acids and their order in a given protein. Certain mutagens (e.g. acridine dyes), which incorporate themselves between the complementary strands of the DNA, may cause errors in replication such that the daughter DNA gains or loses a nucleotide. When this daughter DNA is transcribed, the nucleotides will be read in the correct triplets up to the point of mutation, but the extra or missing nucleotide will cause a shift in the reading frame (to left or right) thereafter, such that all subsequent nucleotides will be read in wrong triplets. The result might be a protein with the wrong amino acids—often it is terminated early—but in any case it is dysfunctional.

reading mistake In genetics, the placement of an incorrect amino acid into a polypeptide chain during protein synthesis.

reafference The stimulation of an animal as a result of the movements of its own body. *Compare* exafference.

realgar Minor accessory mineral of hydrothermal veins, specific gravity 3.5, hardness 1.5–2.0, chemical composition AsS, which is also found at hot springs and in limestones and dolomites. It is distinguished by its red colour, low hardness, and an alteration product of yellow powder. It is red, varying to orange and yellow, transparent to translucent, and has an orange-red streak and a resinous lustre. It crystallizes in the monoclinic system. The crystals are short, striated, and prismatic, but it can be granular and compact.

rear-fanged snakes *See* Colubridae.

recapitulation of phylogeny Theory, due to E. Haeckel (1834–1919), asserting that ontogeny, the development of the individual, recapitulates or reflects the phylogeny, the evolutionary history of the individual. The theory as such has been rejected as not of general applicability, von Baer's 'biogenetic law' being sufficient explanation for the observations on which it was based. However, either hypermorphosis or retardation of sexual maturity can result in individual cases of recapitulation.

Recent *See* Holocene.

receptor site Set of reactive chemical groups in the cell wall of a bacterium that are complementary to a similar set in the tailpiece of a bacteriophage virus. It is through the interaction of these that the virus is able to recognize and attach itself to a host bacterium.

recessional moraine *See* moraine.

recessive gene Gene whose phenotypic effect is expressed in the homozygous state but masked in the presence of the dominant allele (i.e. when the organism is heterozygous for that gene). Usually the dominant gene produces a functional product whereas the recessive allele does not: both one dose and two doses per nucleus of the dominant allele therefore lead to expression of its phenotype, whereas the recessive allele is observed only in the complete absence of the dominant allele.

recipient *See* graft.

reciprocal averaging Ordination method that combines gradient analysis and a system of successive approximation. Its chief merit lies in the clarity with which strong floristic gradients are displayed. For the non-mathematical ecologist the method is conceptually easier to follow and to calculate than the most widely used alternative multivariate evaluation scheme, principal components analysis.

reciprocal cross In genetics, one of a pair of crosses in which the two opposite mating types (or sexes) are each coupled with each of two different genotypes and mated with the reciprocal combination, e.g. male of genotype A × female of genotype B (first cross), and male of genotype B × female of genotype A (the reciprocal cross). Such crosses are used to detect sex linkage, maternal inheritance, or cytoplasmic inheritance.

reciprocal genes Non-allelic genes that reciprocate or complement one another. *See* complementary genes.

recombinant In genetics, an individual or cell with a genotype produced by recombination, i.e. with combinations of genes other than those carried in the parents. Recombination results from independent assortment or crossing over. *See also* genetic engineering.

recombination frequency The number of recombinants divided by the total number of progeny, expressed as a percentage or fraction. Such frequencies indicate relative distances between loci on a genetic map.

recon The smallest unit of DNA capable of recombination.

recreatability (salvageability) Term used by conservationists to denote a community or ecosystem that could be readily re-established following disturbance—by motorway building, open-cast mining, etc.—without any noticeable change. Certain long-established communities (e.g. in Britain primary woodlands) are thought not to be recreatable since they would take many hundreds of years to re-establish their present detailed structure and composition and it is virtually impossible to reconstruct the same long-term environmental influences as fashioned their present form.

recreation ecology The study of the effects on ecosystems of recreation.

rectal gill (branchial basket) Structure found only in the larvae of Anisoptera. The gills project into the rectum in six longitudinal rows, forming the branchial basket. Rectal gills are important for the uptake of salt, as well as for respiration.

rectangular speciation (punctuated equilibrium) The sudden appearance of new species after long periods of little change in the lineage concerned.

Exponents of this theory believe that it explains why there are rarely graded sequences of fossil groups, and why few 'missing links' have actually been found.

Rectangulata (class Gymnolaemata, order Cyclostomata) Suborder of cyclostomes, characterized by the presence of coelomic spaces called 'alveoli' between individuals of the colony. The suborder appeared in the Cretaceous and continues to the present day.

recurrence surface In a peat stratigraphy, the sudden transition from a highly humified peat to a fresh unhumified peat. This change reflects the resumption of wetter conditions and peat growth following a drier period when heath rather than bog plants colonized the older humified peat. Remains of plants characteristic of the hummocks and pools of a growing bog surface are abundant at this transition. *See also* regeneration complex.

red admiral butterfly *See Vanessa atlanta.*

red algae Common name for algae of the class Rhodophyceae. While the majority of marine species are indeed some shade of red, freshwater species may be brown or blue-green. They are known from the Cambrian and were abundant in the succeeding Ordovician.

red-and-green kangaroo paw (*Angiosanthos manglesii*) *See Angiosanthos.*

red-and-white giant flying squirrel (*Petaurista alborufa*) *See* Sciuridae.

redbait (*Emmelichthys nitidus*) *See* Emmelichthyidae.

red beds Sedimentary rocks, generally sandstones, which are red due to their grains being coated with haematite.

red-billed curassow (*Crax blumenbachii*) *See Crax.*

red-billed quelea (*Quelea quelea*) *See* Ploceidae.

red clay Brown or red, very fine-grained, deep-sea deposit composed of finely divided clay material that is derived from the land, transported by winds and ocean currents, and deposited far from land in the deepest parts of the ocean basin, especially in mid-latitudes. Red clay deposits cover about a quarter of the Atlantic and Indian Ocean floors and almost half the Pacific Ocean floor.

red copper ore *See* cuprite.

red coral (*Corallicum*) *See* Scleraxonia.

red-core of strawberry Serious disease of strawberries caused by the fungus *Phytophthora fragariae*. The roots of infected plants become dark brown or black with a characteristic red core. Red-core is a notifiable disease in Britain.

red currant (*Ribes rubrum* (*sylvestre*)) *See* Grossulariaceae; and *Ribes.*

redd Gravelly spawning bed or nest in branches of rivers, made by salmon.

red deer (wapiti, American elk, *Cervus elaphus*) *See* Cervidae.

red emperor (*Lutjanus sebae*) *See* Lutjanidae.

red fox (*Vulpes vulpes*) *See* Canidae.

red grouse (*Lagopus lagopus scoticus*) *See Lagopus.*

redirected behaviour Behaviour that is related to a stimulus, but is misdirected—for example, an attack upon an inanimate object by an animal that cannot or dare not attack another animal that is the true target of its aggression.

red iron ore *See* haematite.

red junglefowl (*Gallus gallus*) *See Gallus.*

red-legged partridge (*Alectoris rufa*) *See Alectoris.*

red light Light of wavelength of about 660 nm, which is involved in phytochrome function.

red locust (*Schistocerca gregaria*) *See* locust.

red meranti *See Shorea.*

red mullet (*Mullus surmuletus*) *See* Mullidae.

red munia (*Amandava amandava*) *See Amandava.*

redox potential Scale indicating the reduction (addition of electrons) and oxidation (removal of electrons) for a given material. The position on the scale is expressed as an electric potential in millivolts, normally in the range 0–1300 or 0–1400 mV. The pH of the sample must be known since this can alter the reading.

redox reaction Reaction involving the transfer of electrons from a donor molecule, the reducing agent, to an acceptor molecule, the oxidizing agent. In some biological oxidations this reaction manifests itself in the removal of hydrogen from a molecule.

red podzolic soil Soil profile formed at an advanced stage of weathering and leaching by the process of podzolization, being similar in appearance and properties to a podzol but associated with the greater degree of chemical weathering and higher iron-oxide concentrations of a humid, tropical environment. *See also* Ultisols.

red ruby *See* corundum.

red rust Important disease of the tea plant (*Camellia sinensis*). Orange-brown, velvety areas appear on the leaves of infected plants. The disease is caused by algae of the genus *Cephaleuros.*

red sea bream (*Pagellus bogaraveo*) *See* Sparidae.

red snow *See Chlamydomonas.*

redstarts *See Phoenicurus.*

red tide Phenomenon in which blooms of certain dinoflagellates colour the water of seas or estuaries red. The dinoflagellates, particularly species of *Gonyaulax*, are concentrated, along with their toxins, by filter-feeding shellfish, and when the shellfish are subsequently eaten by humans poisoning results. Fish and shellfish may also die by poisoning.

reducing sugar Sugar that contains an aldehyde or potential aldehyde group and that has the ability to reduce certain inorganic ions in solution. These include the cupric ions in Fehling's and Benedict's reagents.

reduction Chemical reaction in which atoms or molecules either lose oxygen, or gain hydrogen or electrons.

reduction divisions In genetics, the two nuclear divisions in meiosis that produce daughter nuclei each of which has one half as many centromeres as the parental nucleus.

reduction potential (electrode potential) Quantitative measure of the ease with which a substance is oxidized or reduced. It represents the voltage necessary to prevent the flow of electrons to or from a half-cell containing aqueous solutions of the oxidized and reduced forms of the test substance when it is connected to a hydrogen half-cell.

redundant cistron A cistron (DNA sequence) that is present in many copies on one chromosome, all but one of which are redundant. Examples are the cistrons in the nucleolus organizer coding for the ribosomal RNA molecules.

Reduviidae (order Hemiptera, suborder Heteroptera) Family of bugs, most of which are predators of other arthropods, which they seize with the front pair of legs. They range from delicate, gnat-like forms preying on mosquitoes to large, robust insects capable of tackling heavily armoured, tropical millipedes. A few suck the blood of birds and mammals. There are more than 4000 species, occurring throughout the world but especially in the tropics. *See also* assassin bug; and kissing bug.

Reduvius personatus *See* assassin bug.

red-water fever (cattle tick fever) Disease of cattle and many other animals caused by the protozoon *Babesia*. The parasite invades and destroys the red blood cells: this results in the appearance of haemoglobin in the urine. Many wild animals (e.g. deer) may be symptomless carriers. The disease is transmitted by ticks.

red-whiskered bulbul (*Pycnonotus jocosus*) *See Pycnonotus*.

redwood (coast) (*Sequoia sempervirens*) *See Sequoia*.

reedfish (*Calamoichthys*) *See* Brachiopterygii.

reed grasses *See Phragmites*.

reedmaces *See Typha*; and Typhaceae.

reed warblers *See Acrocephalus*.

reef Rigid, wave-resistant build-up constructed by carbonate organisms. Types of reef include patch reefs (small and circular in shape); pinnacle reefs (conical in form); barrier reefs (separated from the coast by a lagoon); fringing reefs (attached to a coast); and atolls (isolated reefs enclosing lagoons). Factors influencing reef growth include: (a) water temperature (optimum 25 °C); (b) water depth (less than 10 m); (c) salinity (normal marine salinity is necessary); (d) wave action (intense wave action favours coral growth); and (e) turbidity (coral growth requires clear water and an absence of terrigenous suspended sediment).

refection (pseudorumination) In Mammalia, a type of feeding in which food passes rapidly through the gut and is ingested for a second time as it leaves the anus.

reflex action Involuntary action made by an animal in response to a stimulus.

reforestation 1 The establishment of a particular type of woodland by planting into an existing, different woodland type. 2 The replacement of a tree crop by natural or artificial means on land from which a previous wood has been removed.

refugia Small isolated areas where extensive changes, most typically due to changing climate, have not occurred. Plants and animals formerly characteristic of the region in general now find a refuge from the new unfavourable conditions in these areas. An example might be a mountain summit projecting above a glaciated lowland region. *See also* relict; and relict species.

reg Gravel veneer, normally consisting of small, rounded pebbles, that mantles a Saharan plain and has a gradient as low as 1 : 5000. The pebble layer may be underlain by a stony soil, or it may be a lag deposit. *Compare* serir.

Regalecidae (oarfish; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Small family of oceanic fish with a very elongate, ribbon-shaped body, the dorsal fin originating on the head and continuing towards the tiny tail-fin. The first few dorsal finrays are very long and form a crest or crown above the head. The ventral fins are reduced to a single ray trailing below the body. Reputed to reach a length of about 7 m, *Regalecus glesne* (oarfish) has a worldwide distribution. There are two species in the family.

Regalecus glesne (oarfish) *See* Regalecidae.

regeneration complex The cycle of hummock and hollow typical of a growing raised bog. The complex of developmental phases forms a mosaic of patches, each at a different stage of development from its neighbour.

regolith General term for the layer of unconsolidated (non-cemented), weathered material, including rock fragments, mineral grains and all other superficial deposits that rest on unaltered, solid bedrock. It reaches its maximum development in the humid tropics, where depths of several hundreds of metres of weathered rock are found. Its lower limit is the weathering front. Soil is regolith that is able to support rooted plants. *Compare* saprolite.

regression (marine) The progradation of sediments (off-lap) during a rise in sea-level. Shallow-water sediments lie over the sediments characteristic of deeper water. *See* transgression.

regular distribution *See* underdispersion.

regular echinoids Informal term for sea-urchins, of the class Echinoidea, in which the anus is enclosed within the apical system. The term includes the Perischoechinoidea, Diadematacea, and Echinacea.

regular sample (systematic sample) One of a number of samples taken at regular intervals, e.g. by the use of regularly spaced quadrats along some environmental gradient such as a valley side. Though less reliable in certain circumstances than random sampling, systematic sampling may be

more practicable and more economical in the time it takes. The chief disadvantages are the possibility that the interval selected may resonate with some unsuspected environmental variable, so giving biased results, and that the form of the sample does not conform with that theoretically assumed for many statistical tests.

regulator gene In the operon theory of gene regulation, a gene that is involved in switching on or off the transcription of structural genes. When transcribed, the regulator gene produces a repressor protein, which switches off an operator gene and hence the operon that this controls. The regulator gene is not part of the operon, and may even be on a different chromosome. *See also* repressor.

Regulidae (kinglets, titwarblers; order Passeriformes) Family of tiny, loose-feathered birds which have pointed bills and short to medium-length tails. *Regulus* species (kinglets) are mainly green above, and buff below, with bright orange, yellow, or red crown patches. They inhabit coniferous woodland. *Leptopoecile* species (titwarblers) are multicoloured, the females being duller than males: they inhabit scrub and heathland. Members of both genera are insectivorous and nest in trees or bushes. There are two genera, with seven species, often placed in Sylviidae, found in Europe, Asia, and N. America.

Regulus (kinglets) *See* Regulidae.

reindeer (caribou, *Rangifer tarandus*) *See* Cervidae.

reindeer moss Common name for the lichen *Cladonia rangiferina*. This species forms extensively branched podetia up to about 8 cm tall; the apices of the branches are slender and curved, typically all in the same direction. It is found, for example, on peaty ground in mountains and in arctic and sub-arctic regions where, together with other lichens, it forms a major component of the winter diet of reindeer (caribou).

reinforcement The strengthening of a response to a stimulus by reward or punishment.

Reinhardtius hippoglossoides (Greenland halibut) *See* Pleuronectidae.

rejuvenation The marked increase in the rate of erosion that takes place when a land mass is relatively elevated. Streams respond by incision with the development of terraces and nick points, and finally a polycyclic landscape emerges.

relapsing fever Disease of humans caused by species of *Borrelia*; different species are responsible in different geographical regions. Symptoms include recurring bouts of fever. The disease may occur in epidemics, and the mortality rates can be high. It is transmitted by lice or ticks.

relative humidity The water-vapour content of air at a given temperature, expressed as a ratio (the percentage) of the vapour content that would be required for saturation. Generally the relative humidity decreases during the day, with increase of temperature, and increases at night as the temperature falls.

relative-importance value In ecology, a concept similar in principle to importance value, but based on original, somewhat relative, density–frequency–dominance values. It is the actual basal area, frequency, or density of a particular species, without reference to the density, frequency, and dominance values of other species present in the area.

relative pollen frequency (RPF) Expression of pollen data from sediments for each species, genus, or family, as a percentage of the total pollen count, or the total tree pollen. It is the traditional and most widely used method for preparing pollen diagrams. *Compare* absolute pollen frequency; *see also* palynology.

release factors In genetics, specific proteins that interact with the growing polypeptide when a termination codon is encountered during transcription, and then mediate the release of the finished polypeptide from the ribosome.

relevé In phytosociology, the basic field unit recorded. The area should be uniform in floristic composition, and of uniform relief and soil type. The unit size varies with the type of community, but at least should embrace the minimal area. Site and soil data as well as vegetation form, composition, and species, are noted.

relict Applied to organisms that have survived while other related ones have become extinct. Often the term refers to species that have survived periods of unfavourable conditions (e.g. glacial periods or land submergence) by existing in regions called refugia, while becoming extinct elsewhere (e.g. some arctic-alpine plants). It may also refer to a surviving species of a group the other species of which have become extinct (e.g. coelacanth fish).

relict community Community that formerly had a much wider distribution but that now occurs only very locally. Such contraction can be caused by various factors including climatic change, e.g. glaciation. Communities widespread during glacial times may now be restricted to mountain tops, e.g. Upper Teesdale (England) contains isolated flora characteristic of much of lowland Britain during glacial periods.

relict coppice Area of abandoned coppice woodland.

relict sediment Sediments of the continental shelf deposited by processes no longer active in the area where the sediments now occur. Relict sediments are remnants from an earlier environment and are now in disequilibrium. Approximately 50% of the present continental shelves are covered by relict sediments deposited during the period of lower sea-levels in the Pleistocene.

relict soil *See* palaeosol.

relict species Species that formerly had a much wider distribution but that now occur only very locally, often because of climatic change. They may be part of a relict community, e.g. *Dryas octapetala* (mountain avens) in Britain, which was widespread during glacial times but is now mainly restricted to a few mountain tops.

remex (pl. remiges) Flight feather of a bird, the remiges consisting of the primaries and secondaries.

remiges *See* remex.

Remizidae (penduline tits, verdin; order Passeriformes) Family of small, agile, brown or yellow birds, one species of which has a black mask, and all of which have finely pointed bills. They inhabit open country with trees and bushes, or reedbeds; feed on insects and seeds; and build elaborate, globular nests with a side entrance. There are four genera, with 10 species, found in Europe, Asia, Africa, and N. and C. America.

remora *See* Echeneidae.

removal time *See* residence time.

rendzina A brown earth soil of humid or semi-arid grassland that has developed over calcareous parent material. The term is obsolete under the USDA Soil Taxonomy, where rendzinas may fall within the orders Inceptisols or Mollisols.

renewable resource Resource produced as part of the functioning of natural systems at rates comparable with its rate of consumption, e.g. food production by photosynthesis. Limits to renewable resources are determined by flow rate and such resources can provide a sustained yield. *Compare* finite resource.

renewal cycle A biogeochemical cycle.

rengas A group of genera of trees of the family Anacardiaceae of the Malay archipelago producing black sap which is highly irritant to the skin and can be fatal. Even seasoned rengas wood can cause a rash.

reniform Kidney-shaped.

rennin Protease enzyme found in the abomasum (fourth stomach) of ruminants, which causes curdling of milk through the conversion of the soluble protein caseinogen to the insoluble casein. This is then attacked by the enzyme pepsin.

Reoviridae (reoviruses) Group (family) of viruses in which the virions are not enveloped and contain double-stranded RNA in several pieces. The group includes viruses capable of infecting organisms of almost any type: mammals, invertebrates, plants, etc. They appear not to cause significant disease.

reoviruses *See* Reoviridae.

repair synthesis The enzymatic excision and replacement of regions of damaged DNA. The defective single-stranded segments of DNA are cut out, correct bases are inserted using the complementary strand as a template, and these are interlocked by a DNA polymerase. A polynucleotide ligase joins the two ends of the broken strand to complete the repair. An example is the removal by a nuclease enzyme of a thymine dimer that has been induced by UV radiation of the DNA molecule.

replacement Widely-used geological term for denoting a process that involves some kind of transformation. In a petrological sense it refers to the partial or complete alteration of a mineral phase.

replicase Any enzyme capable of catalysing the replication of DNA or RNA in either prokaryotes or eukaryotes.

replication The synthesis of new daughter molecules of nucleic acid from a parent molecule, which acts as a template.

repressor In the operon theory of gene regulation, a protein produced by a regulatory gene that inhibits the activity of an operator gene, and hence switches off an operon. The action of a repressor is determined by some other factor, an effector: either this serves as a co-repressor, and hence is required to switch off the operon; or it inactivates the repressor, and so switches on the operon. *See also* regulator gene.

reproductive Fertile male or female member of a colony of social insects. In ants, bees, and wasps the male (drone) dies soon after insemination, leaving the queen as the colony reproductive. In termites the male (king) lives with the queen, periodically inseminating her. Supplementary reproductives, present in termite colonies, take over colony reproduction if the founding king and queen (the primary reproductives) die.

reproductive isolating mechanism (RIM) The means by which different species are kept reproductively isolated. These may be (a) chromosomal —if cross-mating occurs the incompatibility of the karyotypes makes any hybrid inviable or sterile; (b) mechanical—the two species cannot mate because they are of different sizes, or because the genitalia are shaped differently; (c) ethological—the courtship rituals of the two species diverge at some point so that an incorrect response is given and the sequence is brought to a stop; (d) ecological—the two species occupy different microhabitats and normally do not meet; or (e) other mechanisms include the breeding seasons being out of phase, or members of one species being unattractive to members of the other. Many RIMs, especially ethological ones, amount merely to mate preference, so that in the absence of a preferred partner (of the same species) a member of a different species will be accepted. In this way hybrids between different species may be bred in captivity and may even be found to be fully fertile.

Reptilia (reptiles) Large and varied class of poikilothermic vertebrates, which arose in the Carboniferous from labyrinthodont amphibians. They were the dominant animals of the Mesozoic world and gave rise to the birds and mammals. Reptiles have a body covering of ectodermal scales, sometimes supported by bony scutes. There is no gilled larval phase; development is by amniote egg, but ovovivipary is common. Reptiles are air-breathing from hatching onwards. The kidney is metanephric. The heart is incompletely divided. There are about 6000 species on all continents except Antarctica.

resak *See Vatica*.

Resedaceae Family mostly of herbs, with alternate leaves and flowers borne in long spikes or racemes. The flowers are irregular, with parts in fours to

sevens, but the stamens are often numerous. The 2–6 carpels are superior, and often remain open at their tips, a very unusual feature. *Reseda odorata* (mignonette) has fragrant flowers and is often cultivated. There are six genera, with some 70 species, centred in the Mediterranean area, but extending into Africa, western USA, and India.

Reseda odorata (mignonette) *See* Resedaceae.

resequent Applied to a land-form whose orientation is similar to that of the inferred original feature, but which has passed through a complex subsequent history. For example, a resequent fault-line scarp faces the same way as the original fault scarp, but has passed through the obsequent stage.

reserpine *See Rauvolfia*.

reservoir pool Large and usually abiotic store of a nutrient in a biogeochemical cycle. Exchanges between the reservoir pool and the active pool are typically slow by comparison with exchange within the active pool. Human activity, such as the mining of mineral resources, may profoundly alter this exchange rate, generally releasing an excess into the active pool which can only be accommodated by establishing a new equilibrium. This may in turn produce unfavourable conditions, manifested as chemical pollution, e.g. excess phosphorus in eutrophication, excess sulphur in acid rainfall, and lake acidification. The potential for catastrophic change is such that a point could be reached where re-establishment of the old equilibrium becomes improbable, e.g. if excess carbon dioxide in the atmosphere triggered a runaway greenhouse effect.

reshabar Regional south-easterly wind affecting mountain slopes in S. Kurdestan. The strong, swirling wind is hot and dry in summer but brings cold conditions in winter.

residence time (removal time) 1 (ecol.) The time that a given substance remains in a particular compartment of a biogeochemical cycle. In particular, 'residence time' is used to denote the time taken for pollutants to be removed from the atmosphere by natural processes. 2 (meteorol.) The average length of time that a water molecule or particulate pollutant, for instance, spends in the atmosphere. For pollutants (e.g. dust from a volcanic eruption), the residence time may range from a few weeks in the lower troposphere to several years in the upper stratosphere, before it is scavenged out by precipitation. For water molecules the overall average is believed to be 9–10 days. 3 (ocean.) The average time a particular element of sea-water spends in solution between the time it first enters and the time it is removed permanently from the ocean.

residual (stat.) Data variability that is not accounted for by a particular statistical test. The residuals of individual data values, i.e. their difference from the statistically predicted value, often give ecologists insight into possible environmental influences on the individual data records.

residual body Lysosomal structure containing only indigestible or slowly digestible material and within which enzymatic activity has become virtually exhausted.

resilifer In Bivalvia, the extension of the valve to which the interior hinge ligament is attached.

resilin Naturally-occurring, biological rubber, which returns almost to its former shape if deformed, so conserving most of the energy used in its deformation. Resilin contains two unique amino acids (di- and tri-tyrosine) which give it a characteristic, sapphire-blue fluorescence in ultraviolet light.

resilium In Bivalvia, the name sometimes given to the internal ligament.

resin Exudate of tree wood or bark, liquid but becoming solid on exposure, consisting of a complex of terpenes and similar compounds. It is characteristic of some families, e.g. Dipterocarpaceae, or groups, e.g. the conifers. In many cases it is of economic value for varnishes, etc. It is produced in specialized cells.

resonance Condition of very large wave amplitude, occurring when the frequency of an external wave-generating force matches and amplifies a natural frequency for waves moving to and fro in an enclosed space such as an estuary.

respiration 1 Oxidative reactions in cellular metabolism involving the sequential degradation of food substances and the use of molecular oxygen as a final hydrogen acceptor; ATP, carbon dioxide, and water are the products thus formed. 2 The physico-chemical processes involved in the transportation of oxygen to and carbon dioxide from the tissues. 3 The act of breathing.

respiration–biomass ratio (R/B ratio) The relationship between total community biomass (i.e. standing crop) and respiration. With larger biomass, respiration will increase but the increase will be less if the individual biomass units or organisms are large (reflecting the inverse relationship between size and metabolic rate). Natural communities tend towards larger organisms and complex structure with low respiration rates per unit biomass.

respiration quotient (RQ) The ratio of the amount of carbon dioxide expired to the amount of oxygen consumed during the same period. (RQ = carbon dioxide consumed divided by oxygen utilized.)

respiratory assemblies *See* cristae.

respiratory chain *See* electron-transport chain.

respiratory syncytial virus (RSV) Virus in the Paramyxoviridae which can cause respiratory disease in a range of animals, including cattle and humans.

respiratory trees In holothuroids, an internal respiratory apparatus, consisting of a short tube extending from the posterior end of the intestine, which divides into two longer tubes with numerous, complexly ramifying branches.

resplendent quetzal (*Pharomacrus mocino*) *See* Trogonidae.

Restio (family Restionaceae) Genus of rush-like, monocotyledonous, perennial herbs in which the stems of the plants undertake assimilation. The leaves are reduced to sheaths on the stem. The flowers are small, regular, and dioecious, arranged in spikelets, often in a nodding inflorescence. If the perianth is developed it is composed of two series of dry, often hyaline segments, and has three stamens. The male flowers often have a rudimentary ovary, and in the female flowers several staminodes may be present. The superior ovary is made up of 1–3 carpels with a similar number of locules and styles. The fruit is dry and nut-like, or a three-sided capsule with many endospermic seeds. *Restio* species are present as components of grass and sedge communities which often experience seasonal waterlogging. Commonly, the stems and roots show adaptations to tolerate both dry and very wet conditions. There are 120 species, found in Australia and S. Africa, but with little overlap in the distribution of species between these two regions.

Restionaceae Family of monocotyledons which are rush-like, rhizomatous herbs. They vary considerably in height, from a few centimetres to 2 m. The leaf-blades are rarely developed, although a dry, withered blade may be present, but at each node on the tough, wiry shoots there is a sheathing leaf-base. In some species the leaf-bases are well developed, although not photosynthetic. Ligules are rarely present. The shoots are adapted to become the photosynthetic organs, and are either simple or branched, and in some species very branched. The stems are circular, semicircular, or almost four-sided and sometimes ribbed. Some are solid, others hollow. The flowers are small, regular, and unisexual, and the species are generally dioecious. Flowers are held in spikelets in a panicle. The spikelets are one- or many-flowered, with a sheathing spathe. Where the perianth is developed there are 3–6 thin, dry, similar segments, held in two series. In male flowers there are three stamens, often with the rudiments of an ovary. In female flowers the ovary is superior with 1–3 carpels, and 1–3 locules containing a single ovule. The fruits are dry and nut-like, or three-sided capsules. The seeds contain copious endosperm. There are 28 genera and about 300 species, mostly found in S. Africa and Australia, often in very dry habitats, or those which experience heavy seasonal rains. The shoots and roots show adaptations to drought and to waterlogging respectively. Some species are used for thatching and matting.

resupinate Upside-down. Of a fungal fruit body: flattened against the substrate, with the spore-bearing layer facing outwards.

resurgence The reappearance of surface water that had been diverted underground in a karst region. A major variety is the 'Vauclusian spring', named after the Fontaine de Vaucluse, S. France, and descriptive of the emergence of an underground river.

reticulated python *See Python reticulatus*.

reticulate evolution Creation of a network of closely related taxa within and at the species level, particularly by chromosome doubling or polyploidy. Polyploidy is more common in plants than in animals, and so reticulate evolution is more likely in the former than in the latter.

reticulate method Term sometimes used to describe a non-hierarchical clustering technique.

reticulopodium A branching and anastomosing network of cytoplasmic threads, formed for example by foraminiferans.

reticulum In Ruminantia, the second chamber of the stomach, having a honeycomb-like structure. This is sometimes linked with the rumen, so forming one large chamber.

retinaculum Hook or clasp that projects from the forewing of an insect to allow wing coupling when it is engaged with a hair or spine from the posterior wing. *See* Collembola; and frenulum.

retinol Diterpene compound, composed of four isoprene units structurally related to carotenes, which is involved in the synthesis of the visual pigments. A deficiency of this compound results in a number of symptoms, including cessation of growth, cornification of epithelial structures, and, most notably, night blindness.

Retortamonadida (class Zoomastigophorea) Order of protozoa which live as commensals in the gut of humans and other vertebrates. The cells have 2–4 flagella and may form cysts.

retrices *See* retrix.

retrix (pl. retrices) Tail feather of a bird. There are usually 12 retrices.

retrogression (retrogressive succession) Successional change, usually from an existing climax community, leading to a less diverse, less productive, and less structurally complex community. Usually it is triggered by an environmental factor, e.g. a pollutant.

retrogressive succession *See* retrogression.

Retropinnidae (southern smelt; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of fresh- and brackish-water fish closely related to the smelts of the northern hemisphere (Osmeridae). They are slender, silvery fish, with a single soft-rayed dorsal fin located well back above the anal fin. A small adipose fin is also present. The eyes are rather large. The family comprises two Australian species, including *Retropinna semoni* (8 cm), and two New Zealand species.

Retroviridae (retroviruses) Family of large, enveloped viruses which contain single-stranded RNA. The RNA genome can give rise to a DNA provirus which becomes integrated with the host cell genome. Viruses in this group infect birds and mammals and can cause a range of malignant diseases, including leukaemia and tumour formation.

retroviruses *See* Retroviridae.

return period The frequency, based on statistical analysis of past records, with which a particular environmental hazard may be expected.

reverse mutation (reversion) The production by further mutation of a pre-mutation gene from a mutant gene. This reverse mutation restores the ability of the gene to produce a functional protein. Strictly, reversion is the correction of a mutation, i.e. it occurs at the same site; more loosely, though, the term is applied also to a mutation at another site that masks or suppresses the effect of the first mutation—in fact such organisms are not non-mutant, but double mutants with the same phenotype. *Compare* suppressor mutation.

reversion *See* reverse mutation.

revolute Curved or curled back, most commonly of the edge of a leaf.

revolving storm *See* tropical cyclone.

Rexea solandri (gemfish) *See* Gempylidae.

rhabdites In Turbellaria, rod-shaped bodies of unknown function contained in scattered cells in or below the ectoderm.

Rhabdocoela (Neorhabdocoela; class Turbellaria, subclass Neoophora) Order of platyhelminth worms which possess a simple intestine. The pharynx is present. Most members are free-living.

rhabdome *See* ommatidium.

Rhabdophorina (order Gymnostomatida) Suborder of ciliate protozoa in which the cytostome occurs at the front or to one side of the cell. The organisms prey on other protozoa which they ingest via the expansible cytostome. There are many genera, found in aquatic environments.

Rhabdopleurida (class Pterobranchia) Order of colonial animals in which individuals (zooids) are attached by a contractile stalk to the stolon (pectocaulus). The mesosoma bears one pair of arms. The gonads are unpaired, with a single gonadial opening on the right side. There are no branchial pores. The skeleton (coenoecium) is built of an irregularly branching system of chitinous tubes composed of regular growth bands which are clearly defined by transverse growth lines. Their first known occurrence is in the Upper Cretaceous.

Rhabdornithidae (Philippine creepers; order Passeriformes) Family of small birds which have brown or grey upper-parts, and white under-parts, with streaked flanks. They have long, strong, decurved bills; brush-tipped tongues; long toes; and squared tails. They are arboreal; inhabit thick woodland; climb up and down trees in search of insects; and nest in tree holes. There is one genus, *Rhabdornis*, with two species, found only in the Philippines.

rhabdosome *See* Graptolithina.

Rhabdoviridae (rhabdoviruses) Group (family) of enveloped, RNA-containing viruses, which may infect vertebrates, invertebrates, or plants. The virions are rod-shaped or, in the case of those infecting mammals, bullet-shaped. Viruses are often transmitted from host to host by arthropod vectors. The group includes the causal agent of rabies.

rhabdoviruses *See* Rhabdoviridae.

Rhacochilus toxotes (rubberlip sea perch) *See* Embiotocidae.

Rhacomitrium *See Racomitrium.*

Rhacophoridae (order Anura (Salientia), suborder Diplasiocoela) Family of tropical, arboreal frogs, which have webbed feet with an extra cartilaginous element between the last and next to last finger and toe: there to aid adhesion. Vocal sacs are usually present. Eggs are generally laid in 'nests' of leaves or in foam over water. Species include the Asian 'flying' frogs, which use their large webbed feet as gliding membranes. There are many species, often brightly coloured. They are found in Africa, Madagascar, and SE Asia.

Rhagionidae (snipe flies; class Insecta, order Diptera, suborder Brachycera) Family of flies, most of which lack bristles, and in which the third antennal segment has a terminal style. Some of the tibiae are spurred with pulvilli, and the arolium is pad-like. Squamae are virtually absent, and the wing veins are well-defined. The elongate adult flies are usually predacious on other insects. The larvae are carnivorous in earth or vegetable mould. Adults of *Rhagio scolopacea* have 'swarms' of males which serve as a focal point for mating. There are more than 400 described species.

Rhagodia (family Chenopodiaceae) Genus of herbs and shrubs with alternate or opposite leaves which are simple and flat. The plants can be dioecious or monoecious, and the flowers are either bisexual or unisexual. The flowers are held in small, sessile clusters with the segments in fives, five stamens, and two styles. The fruit is a single-seeded berry, often red in colour. The genus is found widely in Australia, especially on coastal sand hills in southern states. There are 12 species, all endemic to Australia except for one which is also found in New Zealand.

Rhamnaceae Cosmopolitan family of trees and shrubs with simple leaves, and flowers borne in loose clusters. The flowers have their parts in fours or fives, the stamens being opposite the petals; and the 2–4-celled ovary forms a berry in the fruit. A dye (sap-green) has been obtained from *Rhamnus catharticus* (buckthorn); and *Frangula alnus* (alder buckthorn) has been used for making high-quality charcoal for gunpowder. Other members of the family are used as purgatives. Modern classifications recognize about 40 genera, with 500 species.

Rhamnus catharticus (buckthorn) *See* Rhamnaceae.

Rhamphichthyidae (knifefish; class Osteichthyes, subclass Actinopterygii, order Cypriniformes) Small family of freshwater fish which have a very long and tapering body lacking dorsal and pelvic fins, but with a very long anal fin. They have small eyes and a produced snout, with the upper jaw overlapping the lower. Knifefish—e.g. *Eigenmannia virescens* (green knifefish), 46 cm—are known to produce weak electrical discharges which may assist in orientation or food location. There are several species, occurring in S. America.

Rhamphorhynchus Small pterosaur, which had a long tail, a large head, big eyes, and teeth which sloped forward. It was a fish-eater and is known from the Jurassic of Europe and E. Africa.

Rhaphidophoridae (camel crickets, cave crickets; order Orthoptera, suborder Ensifera) Family of wingless, cricket-like insects, most species of which have very slender, elongate legs, and antennae which are longer than the body. They are rather hump-backed. All species live in moist environments, and they often dwell in caves. They are distributed from warmer regions to circum-arctic areas.

Rhaphidophyceae Small class of unicellular algae which are sometimes considered to be members of the Xanthophyceae. The cells are flagellated with two flagella, a forward-pointing tinsel type and a backward-pointing whiplash type. They are found in mud at the bottom of freshwater ponds, etc.

Rhapis (partridge cane; family Palmae) Genus of delicate, forest-undergrowth fan palms which are common as pot plants. They are clump-forming. The leaflets are blunt. The palms are dioecious. The flowers have three free carpels, and 1–3 thinly fleshy fruits are produced per flower. There are 12 species, occurring in Japan and S. China.

Rhea (common rhea; family Rheidae) Monotypic genus comprising *R. americana*, which has grey upper-parts and white under-parts, the male having a black base to its neck. *Pterocnemia pennatus* (Darwin's rhea) is similar, but smaller and with white spots. Rheas are found from NE Brazil to Argentina.

rhea 1 *See* Rheidae. 2 (common rhea, *Rhea americana*) *See Rhea*. 3 (*Boehmeria nivea*) *See Boehmeria*.

Rheidae (rheas; order Rheiformes) Family of large, ostrich-like birds which have long necks; wide, flat bills; short wings with soft feathers; and no tail feathers. Their body plumage is grey-brown and loose-webbed. Their legs are powerful, with three toes, enabling them to run swiftly. They are terrestrial and flightless; inhabit grassland and open brush; feed on vegetable matter and insects; and nest on the ground. There are two monotypic genera, found in S. America.

Rheiformes (rheas; class Aves) Order which comprises one family, Rheidae.

rheotaxis Change in direction of locomotion in a motile organism or cell made in response to the stimulus of a current, usually a water current.

rhesus monkey (*Macaca*) *See* Cercopithecidae.

Rheum (family Polygonaceae) Genus of herbs in which the leaves are large, and palmately lobed. The inflorescence is an erect panicle; the flowers are small and entomophilous. Rhubarb is the petiole of *R. rhaponticum*, and medicinal rhubarb is *R. officinale*. They occur in temperate and subtropical Asia.

rheumatic fever Acute disease which occasionally follows a streptococcal infection such as tonsillitis or scarlet fever. Joints become swollen, red, and painful, and the heart may be affected.

rhinarium In Mammalia, the area of naked skin surrounding the nostrils.

Rhincodontidae (whale shark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Monospecific family of sharks including only *Rhincodon typus* (whale shark), which is thought to reach a length of almost 18 m and has the distinction of being the world's largest fish. Whale sharks are frequently seen swimming near the surface and can be recognized by the exceptionally large gill slits, which extend almost to the tip of the head. Despite their size, these sharks are not aggressive and feed on small planktonic animals. They have a worldwide distribution.

Rhinobatidae (shovelnose ray, guitarfish; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Family of marine rays with a rounded, shark-like trunk, but a broad head with wide, ray-like, pectoral fins, the overall body outline resembling a shovel. Often found in sandy or muddy areas, some species, e.g. *Rhinobatos rhinobatos* (Atlantic guitarfish) may reach a length of about 1 m. There are about 45 species, distributed worldwide.

Rhinobatos rhinobatos (Atlantic guitarfish) *See* Rhinobatidae.

rhinoceros *See* Rhinocerotidae.

rhinoceros beetle *See* Scarabaeidae.

rhinoceros viper *See Bitis nasicornis*.

Rhinocerotidae (rhinoceroses; order Perissodactyla, suborder Ceratomorpha, superfamily Rhinoceratoidea) Family that includes the rhinoceroses and their fossil relatives. They were derived from the Hyracodontidae ('running rhinoceroses') in the Eocene and were prominent in the Oligocene, producing a variety of different types. They are characterized by the molarization of the premolars, the enlargement of the first upper and second lower incisors as cutting teeth (subsequently lost in some lines), and the consequent development of a pointed lip and narrow muzzle, and a simple last upper molar. The skeleton is similar to that of elephants, having vertebrae with long neural spines, and many ribs so the spine and ribs together form a weight-bearing 'girder' resting on the forelimbs and counterbalanced by the weight of the head. All later rhinoceroses have three digits on each limb, but early forms had four. Probably early forms were hornless. While all rhinoceroses tended to large size, some aberrant forms became very large indeed. *Baluchitherium*, a hornless form which lived in Asia during the Oligocene, was about 5.5 m tall at the shoulder, had a long neck and a skull about 1.2 m long and must have weighed about 20 t, making it the largest land mammal ever to have lived. *Elasmotherium*, which may have possessed a very large horn, was also a large form which lived on the Eurasian plains during the Pleistocene. *Coelodonta* was the woolly rhinoceros which lived during the Pleistocene. Today there are four genera, and five species: *Rhinoceros unicornis*, the one-horned Indian form; *R. sondaicus*, the related

Javan species (now very rare); *Dicerorhinus sumatrensis*, the rare two-horned Sumatran form; and *Diceros bicornis* and *Ceratotherium simus*, the African black and white rhinoceroses.

Rhinocerotoidea (superorder Mesaxonia, order Perissodactyla, suborder Ceratomorpha) Superfamily comprising the rhinoceroses and their relatives, grouped into the families Hyracodontidae, Amynodontidae and Rhinocerotidae. They are believed to have evolved from tapir-like forms and throughout most of the Tertiary they were abundant over most of the northern hemisphere. Many developed horns (the name means 'horn-nosed') made from fused hair, and many attained large size, with short legs. Early forms possessed five digits, later forms four and then three, but no member of the superfamily has possessed fewer than three. The digits have nail-like hoofs. The brain is small, eyesight is poor, the most highly developed senses being those of scent and hearing. They are mainly nocturnal and timid. Some graze in small herds.

Rhinochimaeridae (longnose chimaera; class Chondrichthyes, subclass Elasmobranchii, order Chimaeriformes) Small family of marine fish which differ from their relatives, the shortnose chimaeras (Chimaeridae), in having a long and pointed snout. There are about six species, distributed in the Atlantic and Pacific.

Rhinocryptidae (tapaculos; order Passeriformes) Family of small to medium-sized birds which have mainly dark brown or black plumage. They have short, sharp bills, short, rounded wings, and short to long tails that are frequently cocked. They have long legs with large feet, and are mainly terrestrial, walking or running. They inhabit forest undergrowth and grassland; feed on insects and seeds; and nest in holes in banks or trees, or in bushes. There are 12 genera, with about 30 species, found in C. and S. America.

Rhinoderma darwinii (Darwin's frog, mouth-breeding frog; order Anura (Salientia), family Leptodactylidae) Small frog (up to 2.5 cm long) in which the head is pointed with a soft outgrowth on the tip of the snout. The colour is variable, with a dark line running back from each eye. Eggs develop to froglets in the male's vocal pouch. *R. darwinii* occurs in Chile and Argentina.

Rhinolophidae (horseshoe bats; order Chiroptera, suborder Microchiroptera) Family of insectivorous bats, in which the nose-leaf forms a disc, somewhat reminiscent of a horseshoe in shape, with the nostrils visible within it, and above the leaf a spur projecting forward and a lance-shaped extension projecting upward above the eyeline. The ears are pointed, separate, and very mobile, with a prominent antitragus. The tail extends to the edge of the uropatagium. There are two genera, with about 70 species, distributed widely throughout the Old World, but most abundantly in the tropics and subtropics.

Rhinophrynidae (class Amphibia, order Anura (Salientia), suborder Opisthocoela) Family comprising one species only, *Rhinophrynus dorsalis* (Mexican burrowing toad). The tongue is free at the front, and is used to lick up ants and termites. There are no teeth; no external ears; and no free ribs. There is a horny digging 'spade' on the hind feet. The toads spawn after heavy rain. The tadpoles are filter feeders with oral barbels.

Rhinopithecus (langur) *See* Cercopithecidae.

Rhinopomastus (scimitarbills) *See* Phoeniculidae.

Rhinopomatidae (mouse-tailed bats; order Chiroptera, suborder Microchiroptera) Family of bats in which the tail is very long and thin, projecting well beyond the edge of the small uropatagium. A fleshy, naked pad surrounds the nostrils, but is not a true nose-leaf, being used only to close the nostrils between breaths. The bats are distributed throughout northern-hemisphere deserts and arid lands from Africa to Sumatra. There are three species in a single genus, *Rhinopoma*.

Rhinotermitidae (order Isoptera) Family of lower termites, some species of which have nasute soldiers, which immobilize enemies with an adhesive suspension. There are about 150 species, with a worldwide, but mainly tropical, distribution.

rhinovirus Group (genus) of viruses within the Picornaviridae which can cause infections of the respiratory tract, being frequent causal agents of the common cold. They are transmitted by airborne droplets of respiratory-tract secretions.

Rhiphiphoridae (class Insecta, order Coleoptera) Family of black or brown beetles, often with a yellow pattern, 3–30 mm long, in which the body is humped and tapered, frequently with reduced elytra; some females lack wings or elytra. The head is constricted immediately behind the eyes. Males have large, fan-shaped antennae. Larvae are minute; all are insect parasites. *Metoecus* larva, in its oval planidium stage, attaches itself to a *Vespula* wasp and is transported back to the nest. It enters a wasp larva and feeds as an endoparasite; eventually it emerges, moults, and feeds externally on the larva. Other species parasitize cockroaches. There are 250 species.

Rhipidistia Group of crossopterygian ('tassel-finned') fish ranging from the Devonian to the Permian. They possessed two dorsal fins, lobate or stalked pectoral and pelvic fins, and internal nares. Distantly related to the living coelacanth, they are considered by some to be ancestral to the tetrapod, terrestrial vertebrates.

Rhipidura (fantails; family Muscicapidae) Genus of medium-sized flycatchers which have long tails, often held cocked and spread. Most have grey-brown upper-parts and greyish white under-parts, many having a white supercilium and throat. Their tails are grey, black, or rufous, with white tips or white outer feathers. They inhabit dense forests and scrub, and *R. leucophrys* (willie wagtail) is a common garden bird. Fantails feed on insects, and nest in bushes and trees. There are about 40 species, many migratory, found in SE Asia, Australasia, and some Pacific islands.

Rhipidura leucophrys (willie wagtail) *See Rhipidura*.

Rhipsalis (family Cactaceae) Genus of 60 species of epiphytes with cylindrical, branching stems, found mainly in tropical America. They are remarkable in their family in having Old World members in Madagascar and Sri Lanka, but perhaps these were introduced there.

Rhizidiaceae (order Chytridiales) Family of fungi in which a single sporangium arises from an extensive, branched system of threads. Species are found on plant matter in soil and water, where they may play an important role in the degradation of cellulose. Some species are parasitic on freshwater algae.

rhizina *See* rhizine.

rhizine (rhizina) Root-like structure in lichens, made up of fungal hyphae and usually functioning in attachment of the thallus to the substrate.

Rhizobiaceae Family of Gram-negative bacteria in which the cells are typically rod-shaped, and motile with one or more flagella. They are chemo-organotrophic, and can grow only in the presence of air. There are two genera, found in soil and in association with plants. Some species form mutually beneficial (symbiotic) associations with plants, while others cause plant diseases.

Rhizobium (family Rhizobiaceae) Genus of bacteria which bring about the formation of root nodules on leguminous plants. The bacteria live in the root nodules and benefit the plant by making available to it nitrogen which they fix from the atmosphere. There are several species.

Rhizocarpon (family Lecideaceae) Genus of crustose lichens in which the apothecia are lecideine and normally black. Spores are pale to dark brown, one- or three-septate to muriform. All species are found on rocks. *R. geographicum* occurs on siliceous rocks and walls, mainly in hilly districts; the thallus is bright yellow, surrounded and intersected by fine black lines, and dotted with small black apothecia.

Rhizocephala (parasitic barnacles; phylum Arthropoda, subphylum Crustacea, class Cirripedia) Order of naked barnacles which are entirely parasitic, mainly on decapod Crustacea (crabs and lobsters). Rhizocephalans are recognizable as barnacles only in their larval stages. The peduncle comprises foot-like absorption processes which penetrate the host tissues. Appendages and digestive tract are absent. The order includes the genera *Peltogasterella* and *Sacculina*.

Rhizoctonia (class Hyphomycetes) Form-genus of fungi which are responsible for a number of important plant diseases, including 'damping off' of seedlings. Some species have perfect (sexual) states classified in the Basidiomycotina.

rhizoid In mosses and liverworts: a thread-like structure, often serving to anchor the plant (gametophyte) to the substrate; rhizoids can absorb water and minerals. In mosses rhizoids are multicellular, in liverworts they are unicellular.

Rhizomastigida (class Zoomastigophorea) Order of protozoa which can form both pseudopodia and flagella. Most species are free-living in non-saline, stagnant water. Some species are marine, a few are parasitic.

rhizome Horizontally-creeping underground stem which bears roots and leaves and persists from season to season.

rhizomorph In certain fungi, a thick, root-like strand of differentiated hyphae.

rhizomycelium Primitive type of mycelium formed by certain fungi.

Rhizomyidae (bamboo rats; order Rodentia, suborder Myomorpha) Family of burrowing rodents (often considered a subfamily of Muridae), which feed above ground and which resemble American pocket gophers, although they lack cheek pouches. The incisors project below the upper lip; the legs are short and pentadactyl and possess strong claws; and the tail is short and sparsely haired. The head is broad and flat, and the eyes and ears are small. There are about six species, in three genera (*Rhizomys*, *Cannomys*, and *Tachyoryctes*), found in SE Asia and tropical E. Africa.

Rhizophora (family Rhizophoraceae) Important genus of seven species of mangrove trees which are pantropical in distribution, and viviparous. Their timber is good for piles, scaffolding, and charcoal; the bark (cutch) is used for tanning.

Rhizophoraceae Family of trees, shrubs, and climbers of tropical rain forest, in which the leaves are simple, usually opposite, and have caducous stipules. The flowers are hermaphrodite, with 3–16 perigynous or epigynous sepals and petals, eight to many stamens on the edge of the receptacle, and the ovary superior to inferior. They are related to the Combretaceae. There are 16 genera, with 120 species, with a pantropical distribution. Four genera occur as the main trees of mangrove forests, the others occur inland.

Rhizophysaliina (order Siphonophora) Suborder of Cnidaria whose members are characterized by the possession of a large, hollow float provided with a pore. *Physalia* (Portuguese man-of-war) is an example.

rhizoplane (root surface) *See* rhizosphere.

Rhizopodea (superclass Sarcodina) Class of protozoa which feed and move by means of lobopodia or filopodia. Species are free-living in soil, freshwater, or marine environments, or are parasitic in various types of plant and animal.

rhizosphere The area of soil immediately surrounding plant roots, which is altered by their growth, respiration, exchange of nutrients, etc. Within this zone a further zone is sometimes distinguished, called the rhizoplane or root surface.

Rhizostomatida (subclass Scyphomedusae) Order of free medusae lacking tentacles and having the mouth obliterated by the growth across it of eight thick, gelatinous, oral arms, which contain numerous small mouths. These medusae are found in tropical seas, mainly in the Indo-Pacific region.

rhodochrosite Mineral, specific gravity 3.4–3.7, hardness 3.5–4.5, chemical composition $MnCO_3$,

whose name is derived from the Greek for 'rose'. It occurs in hydrothermal veins containing silver, lead, and copper; it also occurs in metamorphic and metasomatically altered rocks of sedimentary origin. It is often a secondary mineral after manganese oxide. It is distinguished by its colour; by the development of a brown or black crust on exposure; and by its solubility, with effervescence, in hot, dilute hydrochloric acid. It is translucent rose-pink, and sometimes light grey to brown, and has a white streak and a vitreous lustre. It crystallizes in the trigonal system. Crystals are rare, but form as rhombohedra and as rod-like, curved crystals, but it is usually massive and granular. It is used for manufacture of ferromanganese, being added to blast-furnace charges, and in the chemical industry.

Rhododendron (family Ericaceae) Genus of shrubs or trees with big, scaly buds; simple, alternate, mostly evergreen leaves; and flowers borne in short racemes or umbel-like clusters, with five-lobed, funnel-shaped to bell-shaped, slightly irregular corollas, and five or ten stamens. Many species and hybrids are cultivated for their splendid flowers, and sometimes for their foliage. If it is incorporated in quantity by bees, *Rhododendron* nectar may render honey poisonous. There are 700–800 species, in three major groups. The *Rhododendron* group includes both showy temperate species, and the *Vireya* group of delicate, tropical species, some of which have scented flowers. The vast majority of species are confined to the mountains of SE Asia and the Himalayas, where the genus probably arose, but a few extend westwards into Europe and N. America, and one to N. Australia. *Azalea* (with five stamens) is sometimes regarded as a separate genus.

Rhodophyceae (red algae) Class of algae which are mostly red in colour; no flagellated cells are formed, and the storage product is a type of starch known as floridean starch. Sexual reproduction tends to be complicated. Red algae may be unicellular, but most are filamentous or membranaceous. The majority occur in the sea, but some are freshwater or terrestrial. The class includes many orders and more than 4000 species. The red seaweeds are more numerous than green and brown seaweeds in temperate and tropical regions, but less numerous in colder regions. Several red seaweeds yield useful products, e.g. agar, algin, and carragheen. The Rhodophyceae is believed to be one of the oldest groups of eukaryotic algae.

rhodopsin (visual purple) The visual pigment found in rod cells in the retina of vertebrates. It is composed of a protein, called an opsin, and retinol, and has an absorption maximum at 500 nm.

Rhodospirillaceae (purple non-sulphur bacteria; order Rhodospirillales) Family of photosynthetic bacteria which require organic compounds as sources of reduction for photosynthesis; they cannot oxidize sulphur. All species are motile, having flagella. The cells are spherical, spiral, ovoid, or rod-shaped, and range in colour from brownish or greenish to purple. Photosynthetic pigments are attached to membranes which are continuous with the cytoplasmic membrane. There are four genera, with 16 species, found in mud in eutrophic ponds, ditches, sewage lagoons, etc.

Rhodospirillales Order of photosynthetic, mainly aquatic, Gram-negative bacteria which contain special chlorophylls called bacteriochlorophylls. Photosynthesis occurs only in the absence of air, and oxygen is not released. Families are Chlorobiaceae, Chloroflexaceae, Chromatiacaeae, and Rhodospirillaceae.

Rhodymeniales (class Rhodophyceae) Order of red seaweeds in which the thallus may be cylindrical or flattened; some (e.g. species of *Lomentaria* and *Chylocladia*) have a segmented or beaded appearance. They are generally found low in the intertidal region, usually attached to rocks. (*Rhodymenia palmata* (dulse) is now called *Palmaria palmata* and is classified in a separate order, the Palmariales.)

Rhoetosaurus brownei One of the earliest sauropod dinosaurs, described initially from the Lower Jurassic, Walloon Coal Measures, of Queensland, Australia.

Rhombifera (subphylum Pelmatozoa) Class of echinoderms, with biserial brachioles and thecal pore structures consisting of rhombic sets of thecal canals. They range from the Lower Ordovician to Upper Devonian.

rhopalioid *See* rhopalium.

rhopalium (rhopalioid) In some Scyphozoa, one of 4–16 club-shaped structures located around the margin of the bell containing concentrations of neurones and involved in control of pulsation.

Rhopalosomatidae (suborder Apocrita, superfamily Pompiloidea) Family of hymenopterans, which are sometimes referred to the Scolioidea, but whose inclusion in the Pompiloidea is based on the possession and development of a preening calcar and strigil on the hind leg. Adults are slender and brownish, 6–25 mm long, and have long antennae each segment of which has two apical spines. The larvae are parasitic on the abdomens of small crickets (Gryllidae).

rhourd *See* draa.

rhubarb *See Rheum*; and Polygonaceae.

Rhus (family Anacardiaceae) Genus of shrubs, small trees, or climbers, which produce a resinous, highly irritant exudate. Several species, e.g. sumac, are ornamentals. *R. toxicodendron* is poison ivy of N. America. *R. verniciflua* of China yields lacquer from the trunk and its powdered leaves yield tannin. There are 250 species, occurring in tropical and warm-temperate regions.

Rhyacichthyidae (loach goby; class Osteichthyes, subclass Actinopterygii, order Perciformes) Possibly monospecific family of freshwater fish which have a flattened head and belly, a low-slung mouth, and small eyes. The two dorsal fins are well separated; the tail-fin and pectoral fins are rather large. The anterior part of the body, together with the pelvic fins, form a type of suction device which enables the fish to secure its position in fast-flowing hill streams. The structure of this suction device is

similar to that found in the true hillstream loaches (family Homalopteridae). There are one or two species, distributed widely in SE Asia. The name 'loach goby' (*Rhyacichthys aspro*, 23 cm), is perhaps unfortunate, as the fish is neither a loach nor a goby.

Rhyacichthys aspro (loach goby) *See* Rhyacichthyidae.

Rhynchobdellida (phylum Annelida, class Hirudinea) Order of exclusively aquatic, parasitic annelids, in which the freshwater forms tend to be flattened in shape. They all have a proboscis. None possess jaws. There are two families.

rhynchocoel In Nemertea, a fluid-filled cavity containing the proboscis.

Rhynchocephalia ('beak-heads', rhynchocephalians; class Reptilia) Order of primitive, lizard-like reptiles dating from the Triassic. The order contains only one species, *Sphenodon punctatus*, the tuatara of New Zealand. This survives only in the Bay of Plenty, and it has protected status (*see* Sphenodontidae). The skull is of the primitive diapsid type, with a fixed quadrate bone. The teeth are fused to the edge of the jaw (acrodont), with a tendency to develop a beak-like structure anteriorly.

Rhynchodina (order Thigmotrichida) Suborder of ciliate protozoa, in which body cilia are sparse or even absent, and in which the cytostome is replaced by a type of sucker. They are parasites or commensals in aquatic molluscs.

rhyncholite One of the beak-like structures which are considered to be the upper jaw structures of fossil cephalopods (phylum Mollusca, class Cephalopoda). They are approximately rhomboidal in shape, with a slightly concave lower surface. The anterior portion is termed the hood, the posterior portion the shaft. The first examples are found in the Carboniferous.

Rhynchonellacea (order Rhynchonellida) Superfamily of Brachiopoda, characterized by impunctate shells and the lack of spondylia. They are first known from the Ordovician. There are 19 extinct and four extant families.

Rhynchonellida (class Articulata) Order of brachiopods, with rostrate shells, functional pedicle, and delthyrium partly restricted by a pair of deltidial plates. The shell is usually impunctate. They appeared first in the Middle Ordovician. The order contains about 250 genera, most of which are extinct.

Rhynchostegium (order Hypnobryales) Genus of slender to robust mosses, in which the stems are procumbent and irregularly branched. The leaves are ovate-lanceolate to broadly ovate, with a nerve extending half way or further up each leaf. The capsule lid has a long beak; the seta is smooth and reddish. The genus contains about 195 species, found mostly in the northern hemisphere. *R. riparioides* is aquatic, growing attached to boulders or tree roots by or in streams. The stems may be up to 15 cm long, sparingly branched, and often lacking leaves on their lower parts. *R. confertum* (formerly *Eurhynchium confertum*) is very common in lowland Britain on stone walls, garden rockeries, etc. The leaves are very small (up to 1 mm long) and the plant is inconspicuous except when the capsules are present.

Rhyncophthirina (class Insecta, order Phthiraptera) Suborder of lice, which are parasitic on elephants and warthogs. Members of the family are distinguished from all other lice by the elongation of the front of the head into a rigid, tubular rostrum, at the end of which are the mouthparts. The mandibles are toothed on the outer surface and are used to drill into the skin of the host. The insect feeds on blood, and the length of the rostrum is related to the thickness of the skin of the host: *Haematomyzus elephantis* (elephant louse) has a much longer rostrum than *H. hopkinsi* (warthog louse). The elephant louse is generally found behind the ears of its host, where the skin is thinnest. The suborder consists of only one family, Haematomyzidae, with one genus, *Haematomyzus*, containing these two species.

Rhynia *See Tmesipteris.*

Rhynochetidae (kagu; order Gruiformes) Monotypic family comprising *Rhynochetos jubatus*, which is a large, grey bird with black, white, and chestnut, barred wings. It has a long, loose crest; a long, sharp, slightly decurved, red bill; and long, red legs with a raised hind toe. It has rounded wings, and a medium-length tail. It is nocturnal, terrestrial, and probably flightless; inhabits forests; feeds on worms, insects, and other animals; and nests on the ground. It is found in New Caledonia.

rhyolite Fine-grained or glassy, acid, volcanic, or sub-volcanic rock.

rhythm *See* periodicity; and circadian rhythm.

Rhytidiadelphus (order Hypnobryales) Genus of large, robust mosses in which the shoots are erect to procumbent. The stems are usually long, and irregularly to pinnately branched. The leaves are broad at the base, gradually or abruptly narrowing to a sharply pointed tip; each leaf may have a short double nerve, or may be nerveless. The seta is deep red and smooth. There are about eight species, mainly found in northern temperate regions, and including some attractive British species. *R. triquetrus* is often conspicuous, with tall, tough, erect stems from which branches arise irregularly to give a bushy habit; the leaves are large and spreading, and capsules are rarely formed. It is found mostly in woodland clearings. *R. squarrosus* is a smaller moss with squarrose leaves; the shoot apices have a characteristic star-like appearance. It is found in moist grassland and is a common weed in lawns.

rhytidome *See* bark.

Rhytisma (family Rhytismataceae, order Phacidiales) Genus of fungi which are parasitic on the leaves of trees. *R. acerinum* is common on the leaves of *Acer pseudoplatanus* (sycamore) where it forms shining black blotches ('tar spots') about 1–2 cm across.

Rhyzopertha dominica (lesser grain borer) *See* Bostrichidae.

ria Drowned river valley in an area of high relief. Classic examples are found in some of the peninsulas of W. Europe, notably W. Ireland, where they have resulted from the post-glacial rise in sea-level.

ribbonfish *See* Trachipteridae.

ribbon worms *See* Nemertini.

Ribeirioida (phylum Mollusca, class Rostroconchia) Order of primitive and very simple rostroconchs which contains the oldest members of the class. All possess a protoconch, and in some forms a pallial line is present. They range in age from Lower Cambrian to Upper Ordovician.

Ribes (family Grossulariaceae) Genus of shrubs with simple, alternate, usually palmately-lobed leaves, and flowers in racemes. These are regular, with four or five sepals, petals, and stamens; and an inferior ovary of two carpels which forms a berry on top, of which the calyx persists. Many species are grown for their edible fruits (e.g. *R. rubrum* (*sylvestre*), red currant; *R. nigrum*, black currant; and *R. uva-crispa*, gooseberry), or for their ornamental flowers. *Ribes* is the only genus in the family, with about 150 species, occurring in the northern temperate zone, and on the mountains of C. and S. America.

Ribes nigrum (black currant) *See Ribes*; and Grossulariaceae.

Ribes rubrum (sylvestre) (red currant) *See Ribes*; and Grossulariaceae.

Ribes uva-crispa (gooseberry) *See Ribes*; and Grossulariaceae.

ribitol Five-carbon sugar alcohol, forming an integral part of the structure of the flavins, riboflavin, FAD, and FMN.

riboflavin Vitamin B_2; it consists of an organic base coupled to ribitol. It occurs widely in nature, being an integral part of the coenzymes FAD and FMN.

ribonuclease Enzyme that catalyses the hydrolysis of RNA, resulting in the formation of mono- and oligonucleotides.

ribonucleic acid (RNA) Nucleic acid characterized by the presence of D-ribose and the pyrimidine base uracil. It occurs in three principal forms, as messenger-RNA, ribosomal-RNA, and transfer-RNA, all of which participate in protein synthesis.

ribose Aldopentose monosaccharide, which comprises the carbohydrate component of RNA.

ribosome Subcellular granule, 10–20 nm in diameter, composed of RNA and protein, which is found in large numbers in all types of cells and in some subcellular organelles. Ribosomes are the site of protein synthesis: m-RNA attaches to them and there receives t-RNA molecules bearing amino acids. In eukaryotic cells they are synthesized in the nucleolus, but are found predominantly in the cytoplasm, singly or in chains (polysomes or polyribosomes, probably linked by the m-RNA), or attached to the endoplasmic reticulum, which is then termed 'rough ER'.

ribulose-1,5-diphosphate (RDP) Phosphorylated derivative of the ketopentose monosaccharide ribulose, which acts as an acceptor molecule for carbon dioxide in the Calvin cycle. The reaction between one molecule each of these two substrates results in the formation of two molecules of phosphoglyceric acid.

Riccia (order Marchantiales) Genus of small, thalloid liverworts in which the thallus may be broad or narrow, and usually branches dichotomously (i.e. forks), often resulting in a rosette-like appearance. There are several British species. *R. glauca* ('crystalwort') is the commonest, found on damp, cultivated soil from early autumn to late spring; the thallus is light glaucous-green. *R. fluitans* is variable in form and may be free-floating in ponds or ditches or may grow on mud; the free-floating form is narrower and more delicate than the terrestrial form.

rice eel (*Monopterus alba*) *See* Synbranchidae.

rice stunt Virus disease which affects rice and other grasses. In addition to stunting, infected rice plants show yellowish streaks on the leaves. The virus is transmitted by sap-sucking leafhoppers.

Ricinidae (order Phthiraptera, suborder Amblycera) Family of chewing lice, which are parasitic on birds of the order Passeriformes. Members of the family are distinguished from all other Amblycera by the lack of labial palps, by the presence of fleshy lobes in front of the mouth (pallettes), and by the fusion of the mesonotum, metanotum, and first abdominal tergum. Many of the species feed on blood, and members of one genus, *Trochiloecetes*, have developed piercing mouthparts analogous to those of the sucking lice. The family comprises three genera: *Ricinus*, *Trochiloectes*, and *Trochiliphagus*, the first being worldwide in distribution and the other two confined to hummingbirds in the New World. There are about 70 species.

Ricinocarpus (wedding bush; family Euphorbiaceae) Genus of erect, monoecious shrubs with opposite or alternate leaves which are often linear and revolute (curved back), without stipules. The flowers are unisexual, but occur in clusters, each of which may comprise both male and female flowers which are held on individual stems. The calyx is fused and lobed; there are 4–6 white petals. The male flowers have a column of numerous stamens fused at the base. The female flowers have a trilocular ovary. The fruit is a capsule. The genus is endemic to Australia, except for one of the 15 species, which is found in New Caledonia. The species occur in the temperate regions of the continent, with most in the west, and no species occurs in both east and west.

Ricinus (family Euphorbiaceae) Genus of one species, *R. communis*, the castor-oil plant, a treelet of Africa now widely naturalized elsewhere. The seeds are poisonous but contain a valuable oil.

Rickettsia (family Rickettsiaceae) Genus of bacteria which can grow only inside the cells of

vertebrate or arthropod hosts. The organisms are rod-shaped, ovoid, or sometimes filamentous. The genus includes the causal agents of typhus fever and various other spotted fevers.

Rickettsiaceae (order Rickettsiales) Family of bacteria in which the cells are parasitic in vertebrate and arthropod hosts; the organisms typically occur inside the cells of the host, though not in red blood cells. There are several genera. Some species can cause important diseases, including typhus, and are transmitted by lice, fleas, ticks, etc.

Rickettsiales Order of prokaryotic organisms which are usually, though not always, regarded as bacteria. The organisms usually have cell walls of the bacterial type and are mostly Gram-negative. Most species are obligately parasitic and can multiply only inside the cells of a living host under natural conditions, although some can be cultivated in cell-free media in the laboratory. Some can cause disease. There are three families.

rictal bristle A stiff, modified feather, with little or no vane, found around the gape of many insectivorous birds, possibly serving to aid the capture of food in flight. *See also* basal bristle.

ridding Area from which a woodland crop has been taken.

ridge (wedge) An extension of high pressure from an anticyclone into a zone where generally lower pressure prevails. The term ridge is also applied to the poleward meanders of the flow of the upper westerly winds over mid latitudes. *See also* long wave.

ridge and runnel A series of asymmetrical ridges running parallel to the coast and separated by shallow troughs or runnels 100–200 m wide. This topography is developed on the foreshore of mesotidal or macrotidal beaches by the back-swash action of waves. The development of these structures is favoured by moderate wave-energy conditions acting on a flat beach with an abundant sediment supply.

rift zone (graben) Elongate trough bounded by two or more faults, which may be associated with alkaline volcanism. The E. African rift zone is an outstanding example. Possibly it was an unsuccessful action progressing toward the formation of a new ocean. *See* aulacogen.

right whale (*Balaena glacialis*) *See* Balaenidae.

rill-wash Eroded material that is concentrated into more or less intermittent trickles and rills on inclined slopes, due to run-off of water.

RIM *See* reproductive isolating mechanism.

rime The white deposit of ice that results from crystal growth on objects that are at a temperature below the freezing point. Supercooled water droplets in fog freeze on contact with such surfaces.

rinderpest (cattle plague, bovine typhus) Disease which affects both wild and domesticated bovines and other animals. It is primarily a disease of the gastrointestinal tract, and mortality rates may be high. The causal agent is a virus of the Paramyxoviridae. The disease occurs chiefly in parts of Africa and Asia.

rindge Method or unit of area measurement used of coppice underwood, and equal to either one square chain (22 by 22 yards, or 20 by 20 metres), or to two chains by one chain (40 by 20 metres).

ring-diffuse species *See* tree-ring.

ring-dyke Steeply dipping dyke of arcuate outcrop formed by the uprise of magma along a steep conical or cylindrical fracture which bounds central collapsed blocks. *See also* cauldron-subsidence.

ringed snake *See Natrix natrix*.

Ringer's solution Physiological saline solution of variable composition, but approximately isotonic with the tissue fluids of animals. It is used extensively in experiments for the temporary maintenance of living cells.

ring-necked pheasant (*Phasianus colchicus*) *See Phasianus*.

ring-porous species *See* tree-ring.

ring spot 1 Ring of pale or yellowish coloration which appears on the leaves of plants infected with certain viruses. 2 Fungus disease of brassicas in which rounded brown spots, about 1 cm across, appear on mature leaves.

ringworm (tinea) Condition in humans and other animals in which a dermatophyte fungus attacks skin, hair, or nails. On the skin the infection takes the form of circular areas of dry, scaling skin; the infection may be contracted by humans from other animals, e.g. cattle, horses, domestic pets.

Rinorea (family Violaceae) Genus of trees and shrubs in which the flowers are almost regular. There are 340 species, occurring in the tropics.

Riodinidae (Nemeobiidae; order Lepidoptera) Family of small butterflies in which the wings are short and broad, generally brownish, with white or blue markings, and eye-spots near the margin of the hindwings. The forelegs are reduced in males but fully formed in females. Riodinidae are closely related to the Lycaenidae. There are about 1000 species, found mainly in tropical America.

Riparia (sand martins; family Hirundinidae) Genus of martins which have pale brown upper-parts and white under-parts, some with a brown throat or throat band. They have a medium-length, slightly forked tail. They are aerial, found near water, feed on insects, and nest in tunnels in banks. There are four species, some migratory, found in Europe, Africa, Asia, and N., C., and S. America.

rip current Strong, narrow current usually of short duration, flowing seaward from the shore. The presence of a rip current can be detected as a visible band of agitated water flowing seawards. Rip currents mark the swift return movement of water piled up on the shore by incoming waves and onshore winds.

ripening Stage in the development of fruit, characterized by the softening, colouring, and sweetening of the tissue, and by a decrease in

acidity. Often this is associated with an increase in the rates of respiration, cell expansion, and ethene production, combined with a loss of chlorophyll.

ripple Small-scale ridge of sand produced by flowing water, wind motion, or wave action. The wavelength or spacing of ripple crests is less than 50 cm usually and the heights are less than 20 cm. Ripple form can be described by the wavelength : height ratio, referred to as the ripple index. Flowing-water ripples have an index of 8–20 and are asymmetric, with a steeper face downstream (lee) and a gentle upstream-facing (stoss) side. The ripple index of wind ripples is 30–70; the structures are much flatter, reaching heights of 1 cm only. Wave-formed or oscillation ripples have a ripple index of 4–16 and have a more symmetrical profile form. The migration of ripples leads to the formation of cross-lamination in sands.

ritualization The modification of patterns of behaviour and their motivation, and their subsequent use in communication, often in stereotyped form.

river blackfish (*Gadopsis marmoratus*) *See* Gadopsidae.

river blindness The name given to extreme infections by the nematode worm *Onchocera*, which is transmitted by black flies (genus *Simulium*, family Simuliidae). Blindness is caused by damage to capillaries resulting from the lodging of the small worms, and the blockage of the blood supply to the eye tissue. *See also* onchocerciasis.

river capture Process whereby a stream is able to tap and so capture the discharge of a neighbour. The capturing stream normally extends by headward erosion along an outcrop of soft rock until it meets and diverts a second, less-favoured, transverse system. A right-angled bend, the 'elbow of capture' is typical of the junction between capturing and captured streams. *See also* avulsion.

river dolphin *See* Platanistidae.

river-jack *See Bitis nasicornis*.

river stingray *See* Potamotrygonidae.

river terrace *See* stream terrace.

Rivularia (order Nostocales) Genus of filamentous cyanobacteria, in which the sheaths surrounding the filaments are confluent, resulting in the formation of tough, hemispherical, gelatinous colonies several millimetres in diameter. They are found on rocks and plants in various aquatic environments, both freshwater and saline.

Rivulus ocellatus (eyed rivulus) *See* Cyprinodontidae.

RNA *See* ribonucleic acid.

RNA tumour virus Oncogenic RNA-containing virus; retrovirus.

roach **1** (entomol.) *See* Blaberidae; Blattellidae; Blattidae; Blattodea; Cryptocercidae; Dictyoptera; *Ectobius*; and Polyphagidae. **2** (American cockroach) *See Periplaneta americana*. **3** (German cockroach) *See Blattella germanica*. **4** (oriental cockroach) *See Blatta orientalis*. **5** (fish, *Rutilus rutilus*) *See* Cyprinidae.

roadrunner, greater (*Geococcyx californianus*) *See* Cuculidae.

roaring forties Popular maritime term for the prevailing westerly winds which are commonly strong over the oceans in temperate latitudes of the southern hemisphere particularly about 40 °S to 50 °S.

robber flies *See* Asilidae.

robber frogs *See* Leptodactylidae.

Robin's pin-cushion gall (rose bedeguar) Red and green or crimson, hairy growth on wild (dog) roses (*Rosa canina*), which is formed by the cynipid wasp *Diplolepis rosae*. Its eggs are laid in leaf buds, although the galls appear to grow from the twig or stem. The galls are multilocular, with an average of 30 progeny emerging in June. The average size of the galls is approximately that of a small pea, but the hairs may attain a length of 35 mm. Reproduction is normally parthenogenetic (offspring arising from unfertilized ova), less than 1% of reared progeny being males. *See also* gall wasp.

Roccella (family Roccellaceae) Genus of lichens, in which the thallus is fruticose, and attached to its substrate by a basal sheath. The pseudothecia are round or elongated. Spores are colourless and usually triseptate. *Roccella* species are found chiefly on rocks by the sea in warmer regions. Some have been used in the manufacture of certain dyes, including the pH indicator litmus.

Roccellaceae (order Arthoniales) Family of lichens, in which the thallus is typically fruticose, and round or flattened in cross-section, or rarely crustose or foliose. The ascocarps are round to irregularly sinuous pseudothecia. Spores are colourless to brown with transverse septa. There are many genera, found mainly on rocks by the sea, mostly in tropical and subtropical regions.

Rochalimaea (family Rickettsiaceae) Genus of bacteria which live parasitically in vertebrate and arthropod hosts; they can be cultivated in cell-free media in the laboratory. They can cause disease in humans, and are transmitted from one individual to another by lice.

roche moutonnée Mound-like land-form of glacial erosion, consisting of a smoothed, streamlined, up-glacier surface and a broken, shattered, lee flank. It probably results from a combination of abrasion, frost-shattering, and the plucking out of blocks by the glacier, although crushing has been suggested as a contributory mechanism.

rock crawlers *See* Grylloblattodea.

rock dove (*Columba livia*) *See Columba*.

rock drumlin *See* drumlin.

rockfish *See* Scorpaenidae.

rock flour Finely-ground rock debris produced chiefly by abrasion beneath a glacier. It may be removed by meltwater streams, which consequently develop a typically milky appearance.

rockfowl *See* Picathartidae.

rock pipit (*Anthus spinoletta*) *See Anthus*.

rock rat (*Petromys typicus*) *See* Petromyidae.

rock salt *See* halite.

rock slaters *See* Ligiidae.

rock sparrows *See Petronia*.

rock thrushes *See Monticola*.

rock tripe Common name for lichens of the family Umbilicariaceae, particularly *Lasallia pustulata* (*Umbilicaria pustulata*); many of these are said to be edible.

rock whiting *See* Odacidae.

Rocky Mountain spotted fever Disease, which occurs in parts of N. America. Symptoms include fever, headache, and pains in joints and muscles; a rash develops on the skin. The causal agent, *Rickettsia rickettsii*, is transmitted by ticks.

Rodentia (Simplicidentata; subclass Theria, infraclass Eutheria, cohort Glires) Order of herbivorous or scavenging mammals in which the incisors are reduced to one pair in each jaw (hence the name 'Simplicidentata'). The incisors have enamel on one surface only and grow continually so that by gnawing they are simultaneously sharpened and kept at a constant length. There is a wide diastema, the second incisors, canines, and first premolars being absent, and the remaining premolars and molars are usually similar in shape. Folds of skin can be taken into the diastema to seal off the mouth into two compartments: material taken into the mouth is not necessarily swallowed. In some rodents these skin folds are developed into cheek pouches. The jaw muscles are large and divided into three parts attached so as to permit a forward and backward jaw movement. The three suborders (Sciuromorpha, Myomorpha, and Hystricomorpha) are distinguished partly by the arrangement of the jaw muscles. Apart from the modifications to the jaws and teeth, rodents are rather unspecialized. Limbs are usually are pentadactyl and clawed. Hind limbs are commonly longer than forelimbs. The digits of the forelimbs are used by many species for handling food. Gait is plantigrade or semi-plantigrade although many species are saltatory. Rodents emerged from eutherian stock during the late Cretaceous or Palaeocene and have shown little tendency to evolve to large size. Today they are distributed throughout the world. There are 1500–2000 species, so that rodents account for nearly half of all mammal species.

Rodriguez solitaire (*Raphus solitarius*) *See* Raphidae.

roe The mass of eggs present in the body cavity of mature female fish.

roe deer (*Capreolus*) *See* Cervidae.

roguing The manual removal of infected or inferior specimens from an otherwise healthy crop of plants.

rollers 1 *See Coracias*; Coraciidae; and Coraciiformes. 2 (Abyssinian roller, *Coracias abyssinica*) *See Coracias*. 3 (groundrollers, long-tailed groundroller, *Uratelornis chimaera*) *See* Brachypteraciidae.

Romneya (family Papaveraceae) Genus of glaucous herbs, which have big, showy flowers, and are grown as ornamentals. There are two species, occuring in California and Mexico

ronquil *See* Bathymasteridae.

rook (*Corvus frugilegus*) *See Corvus*.

root The lower part of a plant, usually underground, by which the plant is anchored and through which water and mineral nutrients enter the plant.

root frequency In the measurement of vegetation frequency, records based solely on the species rooted in a quadrat, as distinct from shoot frequency, which includes those species rooted outside the quadrat but with foliage overlapping into the quadrat.

rooting shank *See Oudemansiella*.

root nodule Small, gall-like growth on the roots of certain types of plant, especially leguminous plants. The nodules develop as a result of infection of the roots by bacteria (*Rhizobium* species in the case of legumes); the bacteria then inhabit the root nodules and benefit the plant by fixing atmospheric nitrogen, much of which becomes available to the plant.

root pressure Pressure developed in the roots of some species of plant which, when the shoot is cut off, causes fluid to exude from the vascular system.

root–shoot ratio Ratio of the amount of plant tissues that have supportive functions to the amount of those that have growth functions. Plants with a higher proportion of roots can compete more effectively for soil nutrients, while those with a higher proportion of shoots can collect more light energy. Large proportions of shoot production are characteristic of vegetation in early successional phases, while high proportions of root production are characteristic of climax vegetational phases.

root surface (rhizoplane) *See* rhizosphere.

Rosa (roses; family Rosaceae) Genus of prickly, often scrambling shrubs, with normally pinnate leaves with stipules. The flowers have usually five sepals and petals, and numerous free stamens and free carpels; but the carpels sit in a deep cup formed by the calyx tube, which becomes fleshy in the fruit, forming the rose hip, a valuable source of vitamin C. It is probably the most widely cultivated ornamental flowering plant. Many species and complex hybrid forms are cultivated for their showy, often fragrant flowers, which range in colour from white, yellow, and red, to a lilac-blue. The separation of the seven chromosome sets in the formation of sexual gametes is uniquely complex and may be a factor in producing their taxonomic diversity. There are well over 100 species, found in the northern temperate zone, with subtropical outliers, but the genus contains many critical taxa whose specific status is uncertain.

Rosaceae Large and heterogeneous family of dicotyledonous trees, shrubs, and herbs, with alternate, stipulate leaves, and regular flowers, usually with inferior or partly inferior ovaries, or

with the sometimes free carpels in a receptacular cup. There are usually four or five free sepals and petals, and numerous stamens. Fruits are very varied. They may be achenes, drupes, follicles, or pomes (as in *Malus*). Many are cultivated for their edible fruits (e.g. *Pyrus*, *Malus*, *Prunus*, *Rubus*, and *Fragaria*), or for their flowers. In modern classifications, some 90 genera, with 2000 species are recognized, mostly in temperate zones, but cosmopolitan overall.

rose *See Rosa*.

rose apple The edible fruits of *Eugenia jambos*.

rose bedeguar *See* Robin's pin-cushion gall.

rose beetle *See* Scarabaeidae.

rose-breasted grosbeak (*Pheucticus ludovicianus*) *See Pheucticus*.

rosefinches *See Carpodacus*.

rosette plant Plant (e.g. *Bellis perennis*, daisy) whose leaves are spread in a horizontal plane from a short axis at ground level. Rosette plants are generally found in sparse or low-growing habitats. The advantages include reduced likelihood of being grazed. *See also* hemicryptophyte.

rosewood *See Dalbergia*.

Rossby waves Named after the Swedish-American meteorologist C.-G. Rossby (1898–1957), equatorward troughs and poleward ridges forming long waves in the circumpolar flow of the upper air, particularly in the mid and upper troposphere, with a typical wavelength of around 2000 km. Three or four waves usually occur in the circumpolar westerly wind flow over mid latitudes. They may remain stationary when wind speed and wavelength have a given relationship. The waves may be initiated by lower winds over mountain barriers, e.g. the Rocky Mountains, or by heating over warm oceans in winter or over land in summer. They are then amplified by vorticity—due to the Earth's rotation—in anticyclonic curvature (in ridges) and in cyclonic curvature (in troughs). Characteristic positions for the main troughs in the upper westerlies over the northern hemisphere are about 70 °W and 150 °E. The Rossby waves influence the formation of surface depressions which tend to develop on a frontal wave ahead of an upper trough.

rostellum In Cestoda, the projection of the scolex (head) that bears two rows of hooks, by which the animal attaches itself to its host.

rostrate Applied to raised or attenuated areas of shells or echinoid tests.

Rostratulidae (painted snipe; family Charadriiformes) Family of medium-sized wading birds which have olive-brown, grey, black, and white, cryptically coloured upper-parts; whitish underparts; and a white central crown stripe. One species has chestnut sides to its head. Females are brighter than males. The bill is long and slightly decurved, the neck and tail are short, the wings are broad, and the legs are long with long toes. Painted snipe are solitary and secretive, inhabit marshes, feed on invertebrates, and nest on the ground. There are two monotypic genera, found in Africa, Asia, Australia, and S. America.

Rostroconchia (phylum Mollusca) Class of extinct, Palaeozoic, bilaterally symmetrical, bivalved molluscs in which the shell has a distinct anterior gape from which a foot probably emerged. The shell resembles that of a pelecypod and is composed of layered calcium carbonate. The internal anatomy is little known. There is no functional dorsal hinge, as in pelecypods. Rostroconchia were entirely marine, and range in age from Lower Cambrian to Permian.

rostrum 1 The forward projection or extension of the snout of a fish. The typical profile of an oceanic shark reveals a massive rostrum projecting well forward and above the low-slung mouth. 2 The snout-like extension to the head that forms the specialized piercing and sucking mouthparts of the Hemiptera (true bugs). The stylets are sheathed by the labrum, which forms a jointed tube closed dorsally at the base by the labrum. In feeding, only the stylets enter the tissues of the host plant or prey.

rotan (rattan) *See Calamus*.

Rotatoria *See* Rotifera.

rotenone Powerful insecticide, of vegetable origin, that acts by inhibiting the electron-transport chain between NADH and cytochrome *b*.

Rotifera (Rotatoria, wheel animalcules; phylum Aschelminthes) Class (or phylum in some classifications) of acoelomate, aschelminth worms in which normally a complete alimentary canal is present, as is a pharynx possessing jaws. Their name is derived from the ciliated crown which in many species gives the appearance when it beats of a rotating wheel. The largest individuals reach 3 mm in length, but most are much smaller. Most are solitary and free-moving, but some are sessile and some colonial. They occur mainly in freshwater habitats. They swim by means of their cilia, or crawl across a substrate by muscular movements. Most are benthic. The body is always covered by a cuticle which may be ornamented. Some feed on suspended matter, others are predatory on protozoa, rotifers, or small metazoan animals. Most are non-parasitic. All reproduce sexually. There are about 1800 species, grouped in two classes: Digononta, comprising the orders Seisonidea and Bdelloidea, and containing rotifers with two ovaries; and Monogonta, with one ovary, comprising the orders Floscullariacea, Collothecacea, and Ploima.

rotor cloud Cloud formed in moist air by condensation in the upper part of an eddy that is generated beneath the wave-form in stable air on the lee side of a mountain barrier. The closed eddy system can result in local reversal of wind direction in the general airstream.

Rotulina (order Clypeasteroida) Suborder of sand-dollars, with flattened tests and a dentate or digitate posterior margin. They first appeared in the Miocene.

rough ER *See* ribosome.

rough flutemouth (*Fistularia villosa*) *See* Fistulariidae.

rough-toothed dolphin (*Steno*) *See* Stenidae.

roughy *See* Trachichthyidae.

round dance *See* dance language; and Nasanov's gland.

roundhead *See* Plesiopidae.

roundness index A measure of the degree of rounding possessed by a pebble. Several techniques are used for determining roundness, including the measurement of the minimum radius of curvature in the principal plane, and the comparison of a pebble with a set of standard silhouettes. The resulting index figure allows inferences to be made about the nature of the depositing process.

roundworms *See* Nematoda.

Rous sarcoma virus Virus of the Retroviridae which causes sarcoma (a tumour of connective tissue) in birds; some strains can also induce tumour formation in other animals.

Roveacrinida (sea-lilies; class Crinoidea, subclass Articulata) Order of small, free-swimming, pelagic sea-lilies in which the conical cup is made up of five radial plates which have largely overgrown the basals. The order appeared in the Triassic and fossils occur in narrow, widespread horizons in the Jurassic and Cretaceous. They became extinct in the late Cretaceous.

rove beetle *See* Staphylinidae.

rowan (*Sorbus aucuparia*) *See Sorbus*.

royal palms *See Roystonea*.

Roystonea (royal palms; family Palmae) Genus of tall, solitary, elegant palms, whose trunks are often bulging. The leaves are pinnate, the crown-shaft prominent. The inflorescences are paniculate, and held below the crown-shaft, twin male flowers flanking a female. The stigma is basal in the fruits. Several are very widely cultivated. There are six species, found in S. Florida, the Caribbean region, and northern S. America.

RPF *See* relative pollen frequency.

RQ *See* respiration quotient.

***r*-selection** Selection for maximizing the intrinsic rate of increase (*r*) of an organism so that when favourable conditions occur, e.g. in a newly-formed habitat, the species concerned can rapidly colonize the area. Such species are opportunists. An opportunist strategy is advantageous in rapidly changing environments as in the early stages of a succession. *See also* biotic potential; *compare K*-selection.

RSV *See* respiratory syncytial virus.

R technique The most usual way to analyse data, in which variables or attributes (*n*) form the data, and the observations for different sample sites or individuals (*N*) form the rows in a table or matrix. *Compare* Q technique; *see also* inverse analysis; and normal analysis technique.

rubber (*Hevea brasiliensis*) *See Hevea*.

rubberlip sea perch (*Rhacochilus toxotes*) *See* Embiotocidae.

rubella *See* German measles.

rubeola *See* measles.

Rubiaceae One of the biggest families of flowering plants, comprising trees, shrubs, and a few herbs, in which the leaves are simple, opposite, and usually have interpetiolar stipules. The flowers are hermaphrodite and tetra- or pentamerous, the corolla tubular, the stamens epipetalous, and the ovary inferior. Various species are the source of quinine, coffee, and many ornamentals. There are about 500 genera, and 7000 species, with a cosmopolitan distribution, but strongly centred in the tropics.

rubidium-87 *See* radiometric dating.

Rubus (blackberry, raspberry; family Rosaceae) Genus, mostly of shrubs but including a few low herbs, often with compound leaves of 3–7 leaflets, and usually with prickly stems. Normally there are five sepals and petals, and many stamens and carpels. The carpels sit on a conical receptacle and ripen to form a cluster of one-seeded drupelets, aggregated into a compound, fleshy fruit. Many species and hybrids are cultivated for their edible fruits. The genus contains very many species, many of which are critical taxa, often of hybrid origin and frequently apomictic (they reproduce asexually through seed formation); perhaps 500 species have been described so far. They are centred in the northern temperate zone, but are cosmopolitan.

ruby *See* corundum.

ruby-tailed cuckoo wasps *See* Chrysididae.

ruby-tailed wasps *See* Chrysididae.

ruby-throated hummingbird (*Archilochus colubris*) *See Archilochus*.

rubythroats *See Luscinia*.

rudaceous rock General term applied to sedimentary rocks having a grain size of 2 mm or more.

ruddy duck (*Oxyura jamaicensis*) *See Oxyura*.

ruderal Plant that is colonizing waste ground.

rudite General name given to rudaceous rocks.

ruff (*Philomachus pugnax*) *See Philomachus*.

ruffe *See* Centrolophidae.

rufous Reddish-brown in colour.

Rugosa (tetracorals; subclass Zoantharia) Extinct order of corals which appeared first in the Cambrian and is last known from the Upper Permian. Members of the order were solitary or compound, with epithelial walls, bilateral symmetry, and metasepta inserted in only four of the six segments formed by the insertion of the six primary septa. There was great diversity of structure in the order, but secondary septa, dissepiments, and tabulae were usually present, and axial structures may have developed. The order contains three suborders, 32 families, and more than 330 genera.

rugose Wrinkled; bearing many ridges.

ruin lizard *See Podarcis sicula.*

rumen *See* ruminant.

Rumex *See* Polygonaceae.

ruminant Member of the suborder Ruminantia, an herbivorous animal with complex digestion characterized by a stomach having three or four parts. In the rumen millions of symbiotic bacteria and other cellulase-producing micro-organisms partially digest the cellulose-rich food. The enzyme cellulase cannot be made by mammals themselves. After some time the partially digested food, the cud, is assembled into pellets in the reticulum ready for regurgitation. The regurgitated cud is chewed thoroughly before passing to the omasum and abomasum where normal digestion occurs. In some ruminants the rumen and reticulum form a single large chamber.

Ruminantia (superorder Paraxonia, order Artiodactyla) Suborder comprising those artiodactyls in which the stomach is complex and some form of rumination occurs. The anterior teeth are much modified, with the canines usually reduced, and the cheek teeth are selenodont. The mastoid region is exposed on the skull surface. Some authorities restrict the Ruminantia to the higher ruminants, excluding the modern camels and their ancestors; others allow two infra-orders, Tylopoda for the camel group and Pecora for the remainder.

ruminate Of the endosperm, pale with an irregular pattern of dark lines, looking as though chewed.

Rupicola (cock-of-the-rock) *See* Cotingidae.

Ruppiaceae Aquatic, monocotyledonous family of submerged herbs, usually of brackish or salt waters, with linear or bristle-like leaves, sheathing at their bases, and short, terminal racemes of minute flowers. These have no perianths, two stamens, and an ovary of four or more free carpels, which develop long, separate pedicels in the fruit, forming an umbel-like structure. Pollen grains are elongate in shape, and rise to the surface in a 'bubble' of air, where pollination occurs. There is one genus, *Ruppia*, and two or three species, occurring throughout temperate and subtropical regions, and in tropical mountain lakes.

rushes *See Juncus.*

Russian borer *See* peat-borer.

Russula (family Russulaceae) Genus of fungi, which form fragile fruit bodies which typically have brightly-coloured caps. Some species are edible, a few are poisonous. They are found on the ground under trees, with which they often form mycorrhizal associations.

Russulaceae (order Agaricales) Large family of fungi in which the tissue of the fruit bodies contains sphaerocysts bound by connective hyphae. Spores have ornamentations that turn dark violet when treated with iodine. There are two genera, with many species, and they are found on the ground under trees.

rust Plant disease caused by a fungus of the order Uredinales. The characteristic symptom is the development of spots or pustules bearing masses of powdery spores which are usually rust-coloured, yellow, or brown. Infected plants may also show distortions or gall-like swellings.

Rutaceae Family of trees and shrubs which are sometimes thorny. The leaves are mostly compound, gland-dotted, aromatic when crushed, without stipules, and sometimes opposite. The flowers are regular, hermaphrodite, tetra- or pentamerous with a disc; and the ovary is usually superior and composed of several fused carpels. There are 150 genera, with 900 species, occurring in tropical and warm-temperate regions, and well represented in Australia and S. Africa.

rutile Accessory mineral, in a variety of igneous rocks, schists, gneisses, and metamorphic limestones and quartzites, which also becomes concentrated in alluvial deposits and beach sands. It has specific gravity 4.2–4.4, hardness 6.0–6.5, and chemical composition TiO_2. It is distinguished by its red colour and crystal form. Normally it is reddish-brown, but it can also be yellowish-red, or black. It has a pale brown streak, and an adamantine lustre. It crystallizes in the tetragonal system. The crystals are normally square prisms terminated by pyramids. It is the major ore for titanium and its compounds.

Rutilus rutilus (roach) *See* Cyprinidae.

Rutoceratida (class Cephalopoda, subclass Nautiloidea) Order of evolute, gyroconic cephalopods in which the siphuncle is small and near the centre of the chambers. The sutures are trilobed. Members are characterized by outgrowths, e.g. spines or nodes. The order ranges in age from Lower Devonian to Middle Jurassic.

***R* value** Usually, the multiple correlation coefficient, as distinct from *r*, the simple correlation coefficient.

Rynchopidae (skimmers; family Charadriiformes) Family of large water birds which have black or brown upper-parts and white under-parts. The bill is long, with the lower mandible longer than the upper. They have long, pointed wings; short, forked tails; and very short legs with small, webbed feet. They inhabit coasts and rivers, and feed on small fish and crustaceans caught by skimming over the water with the lower mandible ploughing the surface. They nest on the ground. There is one genus, *Rhynchops*, with three species, found in Africa, S. Asia, and N., C., and S. America.

S

S *See* sulphur.

s *See* selection coefficient.

Sabal (palmetto palm; family Palmae) Genus of very hardy fan palms, most of which have a trunk, but some of which occur as stemless clumps. The inflorescences are formed among the leaves. The flowers are hermaphrodite. Several are extensively cultivated. There are 14 species, found in southern USA, the Caribbean, and (one species) in northern S. America.

sabkha Wide area of coastal flats bordering a lagoon, where evaporites, dominated by carbonate-sulphate deposits, are formed. It is named after such an area on the Trucial coast of Arabia.

sablefish *See* Anoplopomatidae.

sabretooth *See* Evermanellidae.

saccharide Alternative term for sugar.

Saccharomyces (family Saccharomycetaceae) Genus of yeasts which includes some economically important species and strains. In the absence of air, *S. cerevisiae* can ferment sugar to alcohol and carbon dioxide, and strains of this species are used in bread-making, brewing, wine-making, etc. The cells of *S. cerevisiae* are small and elliptical, and reproduce by budding. *Saccharomyces* is found naturally on ripe fruit.

Saccharomycetaceae (order Endomycetales) Family of fungi in which the vegetative stage is composed of single cells which reproduce by budding. Mycelium is formed occasionally in some genera. Most of the ascospore-forming yeasts belong to this family, including some of economic importance (e.g. *Saccharomyces*). Saccharomycetaceae are chiefly saprotrophic, and found in a range of habitats.

Saccharum (family Gramineae) Genus of large, robust, perennial grasses, only two species of which are known in the wild. Sugarcane is *S. officinarum*, the only world crop originating from New Guinea. The stem is solid, containing sugar in the soft tissues. There are six species, occurring in the Old World tropics and subtropics.

Saccobranchidae Alternative name for the fish family Heteropneustidae.

Saccominopsis Known from the Ordovician, this genus is thought to be the first representative of the very important protozoan group the fusilinids.

Saccopharyngidae (whiptail gulper; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of deep-sea fish which have an elongate body, a long, whip-like tail, a large mouth, and eyes placed close to the tip of the snout. There are possibly four species, distributed worldwide.

Sacculina carcini (parasitic barnacle; class Cirripedia, order Rhizocephala) One of more than 50 species which parasitize crabs; the adult *S. carcini* comprises a sac on the under-side of the crab, with a complex network of feeding roots, the 'interna', which penetrates the whole of the host's body, even the tips of the limbs. The developmental stages comprise a four-instar nauplius larva and a cypris larva. The latter attaches itself to a seta of a young crab by its antennules, and then casts its limbs. The resulting, sac-like animal develops a hollow, dart-like structure, the 'kentron', which pierces the crab's cuticle. By now, the contents of the sac are a mass of undifferentiated cells, and this mass is injected into the host, where it migrates to a position below the crab's gut. Roots develop and spread from a small, central body. The body grows, and pierces the under-side of the crab. This visible part can grow to just under 4 cm in diameter, and is dull yellow in colour. The parasite is now adult, and the life cycle takes about nine months. Infected crabs cannot moult, but live for about two years. The gonads fail to develop, an effect called 'parasitic castration', and males undergo feminization, and lack secondary sexual characters. *S. carcini* is usually found on *Carcinus maenas* (common shore crab), though it is known from eight other species. There are more than 80 species of *Sacculina*.

sacfry Recently hatched fish larvae that are still in possession of the yolk sac.

Sacoglossa (Ascoglossa; phylum Mollusca, class Gastropoda) Relatively small order of opisthobranch gastropods, in which individuals are small and may be primitively shelled, bivalved, or naked. They feed with a radula and suctorial mouth on the cell fluids of algae. Usually they feed on green algae, but some certainly feed on red algae and there are reports of sacoglossans feeding on large diatoms and on sea grasses. Some feed suctorially on eggs of opisthobranchs. Several genera of sacoglossans are able to retain functional chloroplasts from their food algae, and benefit nutritionally from the photosynthetic activity of the chloroplasts. Gills are usually lacking, but rarely one may be present. They are named after the sac ('ascus sac') into which worn teeth normally pass (rather than being shed as are teeth in other opisthobranchs). Sacoglossa are not known in the fossil record.

sacral vertebra *See* lumbar vertebra.

sacred scarab (*Scarabaeus sacer*) *See* Scarabaeidae.

sac-winged bat *See* Emballonuridae.

saddle fungus Common name for the saddle-shaped fruit bodies of a fungus of the genus *Helvella*; also an alternative name for dryad's saddle.

saffron Colouring and flavouring obtained from *Crocus sativus*. *See also Crocus*.

sage *See Salvia*.

sagitta *See* earstone.

Sagittariidae (secretary bird; order Falconiformes) Monotypic family comprising *Sagittarius serpentarius*, which is a large, grey bird with black thighs and flight feathers. It has a long neck and its nape has elongated feathers. The face is bare with a short, hooked bill. The legs are very long, with short toes which are webbed basally. The wings are large, and the tail is long, with long central feathers. It inhabits open plains; feeds on reptiles, particularly snakes, small mammals, and insects; and nests in a bush or tree. It is found in Africa.

Sagittarius serpentarius (secretary bird) *See* Sagittariidae.

sago *See Cycas*.

sago palm (*Metroxylon sagu*) *See Metroxylon*.

Saguinus (tamarin) *See* Callitrichidae.

Sahel zone The semi-arid southern border of the Sahara in W. Africa, which supports a very dry type of savannah which includes scattered, thorny trees. In recent years the desert has advanced appreciably into the Sahel zone, partly at least as the result of poor land management.

Sahulland Name often given to the tropical portion of the combined Australia–New Guinea land mass, as it existed at times of low sea-level during the Pleistocene. The faunas of the two present-day components have great similarities, the differences being due mainly to the fact that New Guinea is largely forested and Australia is largely open country. The Sahul shelf, linking New Guinea with Australia, is less than 200 m below the present sea-level.

saiga (*Saiga tatarica*) *See* Bovidae.

Saiga tatarica (saiga) *See* Bovidae.

sailfish (*Istiophorus platypterus*) *See* Istiophoridae.

sailor beetle *See* Cantharidae.

St Kilda wren *See* race.

St Mark's fly *See Bibio marci*.

St Peter's fish (*Zeus faber*) *See* Zeidae.

saithe (*Pollachius virens*) *See* demersal fish.

sal (*Shorea robusta*) *See Shorea*.

salac (*Salacca edulis*) *See Salacca*.

Salacca (family Palmae) Genus of spiny palms which are usually stemless and occur as big, dense, clumped rosettes. The leaves are pinnate, and large. These palms are dioecious, inflorescences bursting through the leaf sheaths, sparsely branched into stout, flexuous spikes, the flowers on them crowded. The fruits are scaly. There are 1–3 seeds embedded in a pulp. *S. edulis* (salac) is widely cultivated, especially in Java for its sweet, edible fruit. There are 15 species, found from Assam to Sumatra, Malaya, Java, Borneo, and the Philippines.

salamanders *See* Salamandridae; and Plethodontidae.

Salamandra atra (alpine salamander, black salamander; order Urodela (Caudata), family Salamandridae) Terrestrial, black salamander which is ovoviviparous. One larva develops per oviduct and feeds on the other eggs. Two fully developed, terrestrial young are produced after 2–3 years' development in high-altitude forms. It occurs in the Alps, Albania, and Hercegovina.

Salamandra salamandra (fire salamander; order Urodela (Caudata), family Salamandridae) Salamander which grows to 16 cm long. It is glossy black, with yellow, orange, or red blotches. It rarely enters water, even mating on land. It is ovoviviparous, with a short larval phase. It is a nocturnal carnivore, preying on terrestrial invertebrates. It occurs from S., W., and C. Europe to Asia Minor.

Salamandridae (newts, 'true' salamanders; class Amphibia, order Urodela (Caudata) Family of salamanders in which the adults have long palatal teeth, lungs, a cylindrical body, and well-developed legs and tail. The skin of some species contains powerful toxins. There are about 90 species, both terrestrial and aquatic, from Europe, N. America, N. Africa, and parts of Asia.

Salangidae (icefish, glassfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Family of slender, marine fish with cigar-shaped bodies, which are scaleless and almost transparent. They show a pointed head; a large anal fin; a single, soft-rayed, dorsal fin; as well as a forked tail-fin and a small adipose fin. Icefish, e.g. *Salangichthys microdon* (10 cm), are small, but nevertheless important as food fish. There are 14 species, found in the NW Pacific.

Saldidae (shorebugs; order Hemiptera, suborder Heteroptera) Family of active, big-eyed, predatory bugs which are often found in damp places with little vegetation, e.g. shores of rivers, lakes, and estuaries. There are about 300 species, distributed worldwide.

Salenioida (superorder Echinacea) Order of regular echinoids, similar to the Cidaroida, but characterized by the presence of one or several large, polygonal plates developed on the periproct, within the ring of ocular and genital plates. They first appeared in the Lower Jurassic.

Salicaceae Family of dicotyledonous trees and shrubs, with alternate, deciduous, simple leaves with stipules, and tiny flowers, in unisexual catkins, which are borne on separate male and female plants. The flowers have no perianth, merely a basal bract; and have either two to many stamens, or a one-celled, bicarpellary ovary with two stigmas. The trees are mainly wind-pollinated. The fruits are capsules, and the seeds bear long, silky hairs, which help in wind dispersal. Some are important timber trees. There are three or four genera—*Salix*, *Populus*, and the monotypic *Chosenia* (found only in NE Asia), with some classifications including *Toisusu*—comprising 330–350 species, most occurring in the northern temperate zone.

salic horizon Soil horizon, usually below the surface, containing not less than 2% salt and with a figure of 60 or more for the value calculated as the thickness of the horizon in centimetres multiplied by the percentage of salt. It is a diagnostic horizon of the USDA Soil Taxonomy.

Salicornia (glassworts; family Chenopodiaceae) Genus of annual herbs and some woody perennials, with succulent leaves in opposite pairs, so fused to the stem and to each other that at first sight the plants appear to consist of jointed, cylindrical, fleshy segments, with only the tips of the leaves free. The flowers are solitary, or in groups of three, in the leaf axils, and are almost wholly immersed in the fleshy stems. They each consist of one or two stamens and a single carpel. They inhabit salt-marshes in coastal or arid regions, and are important colonists of tidal mud-flats. They have extremely high internal suction pressures (up to more than 100 atmospheres) which enable them to take up water from strongly saline solutions. Some species are pickled and eaten as a vegetable. The genus is very critical, but probably contains at least 50 species, and is cosmopolitan in suitable habitats.

Salientia *See* Anura.

salination *See* salinization.

saline 1 Apertaining to salt. 2 An aqueous solution of sodium chloride, with or without other salts, and approximately isotonic with body fluids, that is employed for the temporary maintenance of living cells and tissues.

saline-sodic soil Soil that contains more than 15% exchangeable sodium, a saturation extract with a conductivity of more than 4 mmho/cm (25 °C) and in the saturated soil usually has a pH of 8.5 or less. Either high concentration of salts or high pH, or both, interfere with the growth of most plants.

saline soil Soil that contains enough soluble salt to reduce its fertility. The lower limit is usually defined as 0.4 siemens per metre (4 mmhos/cm).

salinity Measure of the quantity of total dissolved solids in sea-water in parts per thousand by weight when all the carbonate has been converted to oxide, the bromide and iodide to chloride, and all the organic matter is completely oxidized. Ocean water salinity varies in the range 33–38 parts per thousand, with an average of 35 parts per thousand.

salinization (US salination) The process of accumulating soluble salts in soil, usually by an upward capillary movement from a saline groundwater source.

salivary-gland chromosome Polytene chromosomes found in the interphase nuclei of the salivary-gland cells in larvae of Diptera (true flies). These chromosomes undergo complete somatic pairing to form units of identical chromosomes joined along their length (in parallel) to one another.

Salix (willows; family Salicaceae) Genus of trees, some of them large, and shrubs, many of which are dwarf alpine or arctic species. The catkin scales are untoothed (they are toothed in *Populus*); there are only 2–5 stamens; and nectaries are present in the flowers which (unlike those of *Populus*) are insect-pollinated. The buds are enveloped by a single outer scale (there are several in *Populus*). *S. alba* var. *caerulea* is the best tree from which to make cricket bats. There are about 300 species, most of them northern temperate or arctic, but with a few tropical and southern temperate outliers.

Salmo gairdneri (rainbow trout) *See* Salmonidae.

salmon *See* Salmonidae.

Salmonella (family Enterobacteriaceae) Genus of Gram-negative, rod-shaped bacteria. Most species are motile with many flagella. The genus includes some important disease-causing species, including the causal agents of typhoid fever, and some types of 'food poisoning'.

salmonellosis Any disease of humans or other animals in which the causal agent is a bacterium of the genus *Salmonella*.

salmonherring (*Chanos chanos*) *See* Chanidae.

Salmonidae (salmon, trout; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Fairly large family of freshwater fish, although a number of species spend several years in the sea before returning to the river to spawn. They have an elongate body, with the soft-rayed, single, dorsal and pelvic fins placed about mid-way along the trunk; there is a small adipose fin, and the tail-fin is slightly forked. Most are medium to large fish, inhabiting the cold to temperate freshwater systems of the northern hemisphere. Many species, e.g. *Salmo salar* (Atlantic salmon), 1.3 m, and *S. gairdneri* (rainbow trout), 1.2 m, are of considerable commercial importance. A number of species have been introduced into other countries in order to improve the local fisheries. There are about 70 species.

Salmoniformes Order of bony fish with a single dorsal fin which, like the pelvic fins, is placed half way along the body or further to the back of the animal. The order incorporates some 24 families, including for example the Salmonidae, the Esocidae, and the Osmeridae.

Salmo salar (Atlantic salmon) *See* Salmonidae.

Salpornis spilonotus (spotted creeper) *See* Salpornithidae.

Salpornithidae (spotted creeper; order Passeriformes) Monotypic family comprising *Salpornis spilonotus*, which is a small, white-spotted, brown bird, with a long, slender, decurved bill. It is often placed in the family Certhiidae, but differs in that its tail is rounded and lacks stiff feather shafts. It inhabits woodland and bush; feeds on insects, which it locates by climbing up and down tree trunks; and nests on a branch. It is found in Africa and Asia. *See also* Certhiidae.

SALR *See* saturated adiabatic lapse rate.

salsify (*Tragopogon porrifolius*) *See* Compositae.

saltation Major process of particle transport in either air or water, which involves an initial steep lift followed by travel and then a gentle descent to the bed. An essential requirement for the process

is turbulent flow that can lift particles into the zone of relatively high downstream (downwind) velocity.

saltatorial *See* Orthoptera.

saltators *See* Cardinalidae.

saltatory Leaping.

salt flat Extensive flat surface, found in hot deserts, consisting of salts that have accumulated in a shallow saline lake or playa. Evaporation then produces a crust of varying hardness.

Salticidae (jumping spiders; order Araneae, suborder Araneomorphae) Family of spiders which have only two tarsal claws. They are medium to small spiders in which the carapace is square-fronted. The anterior median eyes are much larger than the others and members of this family have the greatest visual acuity of any arthropod, also perhaps being sensitive to the colour and plane of polarized light. Prey is jumped on from a distance of a few centimetres by rapid elevation of the internal body pressure which extends the legs. Many species mimic ants, and all have complex visual courtship and threat displays. Most of the 4000 or so species are tropical, although there are northern temperate and even arctic species.

salt-marsh Vegetation often found on mud banks formed at river mouths, showing regular zonation reflecting the length of time different areas are inundated by tides. Sea-water has a high salt content which produces problems of osmotic pressure for the vegetation, so that only plants that are adapted to this environment (halophytes) can survive.

saltpetre Mineral, specific gravity 1.9, hardness 2.0, chemical composition KNO_3. It is found in hot, arid regions, together with Chile saltpetre, halite, and gypsum. It is usually grey-white, and it has an earthy lustre. It crystallizes in the orthorhombic system. It usually occurs in a massive form.

salt-secreting gland *See* Hydrophiidae; and *Crocodylus porosus*.

salt stress Osmotic forces exerted on plants when they are growing in a saltmarsh or under other excessively saline conditions.

salt-water crocodile *See Crocodylus porosus*.

salt wedge Intrusion of sea-water into a tidal estuary in the form of a wedge along the bed of the estuary. The lighter fresh water from riverine sources overrides the denser salt water from marine sources unless mixing of the water masses is caused by estuarine topography. Salt wedges are found in estuaries where a large river discharges through a relatively narrow channel.

salvageability *See* recreatability.

Salvia (sage; family Labiatae) Genus of herbs and low shrubs, usually with aromatic foliage, and with flowers that occur in whorled spikes, often with coloured bracts. The flowers have the corolla strongly two-lipped, with the upper lip often strongly arched over the two stamens. These each have only one anther cell developed, on one end of a flexible, see-saw-like connective on the tip of the filament, making the stamen appear branched, with the anther cell on the tip of the longer 'branch'. Many species are cultivated as pot-herbs, or for their showy flowers. There are some 500 species, centred in S. Europe and SW Asia, but occurring widely in tropical and temperate zones.

Salviniaceae Family of ferns of specialized, floating, aquatic habit, that have no roots, and leaves in whorls of three, two of which are oval and float while the third is submerged and divided into root-like, descending lobes. The floating leaves are covered with hairs and waxy papillae, and are concave above. The slender stems contain a vascular strand surrounding a tiny pith. The sporangia are of two kinds, megasporangia and microsporangia, borne in separate sporocarps on the tips of the root-like branches of the submerged leaves. The megaspores germinate to form green, female gametophytes floating at the water surface. There is one genus, with 13 species, mostly in tropical Africa, but also present in tropical and temperate America.

samara Winged, one-seeded nut or achene, characteristic of *Acer*, but also found in many other plants.

Sambucus (elders; family Caprifoliaceae) Genus of deciduous trees, shrubs, and a few herbs, with opposite, pinnate leaves, and a large stem pith. The flowers are in umbel- or panicle-like clusters, and usually have a five-lobed corolla, and five stamens. The ovary is 3–5-celled, and ripens to a berry-like drupe in the fruit. The fruits of *S. nigra* are edible, and they and the flowers can be made into wine. There are about 20 species, widespread in temperate and tropical regions, but absent from C. and S. Africa.

Samolus (family Primulaceae) Genus of annual or perennial herbs which have erect or trailing stems, and glabrous, radical, or alternate leaves. The flowers are bisexual and held in terminal racemes. The sepals are fused into a five-lobed, bell-shaped calyx, and the corolla is also fused into a short but broad tube. There are five stamens, and the ovary and fruit are half-inferior, the fruit being a valvate capsule. The genus is represented in swamps and rivers, often in coastal areas or inland marshes. There are about 10 species, all found in the southern hemisphere, one of which is endemic to Australia.

sampling *See* contagious distribution; plotless sample; random sample; regular sample; stratified random sample; and transect.

samul (silkcotton, *Bombax milebaricum*) *See Bombax*.

sand (pedol.) 1 Mineral particles of diameter 2–0.02 μm in the international system, or 2–0.05 μm in the USDA system. 2 A class of soil texture.

sandalwood *See Santalum*.

sand cockroaches *See* Polyphagidae.

sand crickets *See* Stenolpelmatidae.

sand diver *See* Trichonotidae.

sand-dollars *See* Echinoidea; Clypeasterina; Clypeasteroida; Laganina; Rotulina; and Scutellina.

sand-eel (*Ammodytes tobianus*) *See* Ammodytidae.

sanderling (*Calidris alba*) *See Calidris*.

sandfish 1 (*Gonorynchus greyi*) *See* Gonorynchidae. 2 *See* Leptoscopidae. 3 *See* Trichodontidae.

sand fly *See* Psychodidae.

sand-fly fever (phlebotomus fever) Fever due to infection by a virus introduced by the bite of a sand fly (*Phlebotomus*).

sand gobies *See* Kraemeriidae.

sandgrouse *See* Columbiformes; Pteroclidae; and *Syrrhaptes*.

sandhopper *See* Amphipoda.

sand-lance (*Ammodytes tobianus*) *See* Ammodytidae.

sand lizard *See Lacerta agilis*.

sand martins *See Riparia*.

sand perch *See* Mugiloididae.

sand pillar *See* dust devil.

sandpipers *See Calidris*; Scolopacidae; and *Tringa*.

sand ribbon Longitudinal strip of sand up to 15 km long, 200 m wide and less than 1 m thick, standing on, and surrounded by, an immobile gravel floor. Sand ribbons are developed on the continental shelf sea-floor where there are a paucity of sand, water depths of 20–100 m, and fast-flowing currents.

sand smelts (silversides) *See* Atherinidae.

sand stargazer *See* Dactyloscopidae.

sandstone Sedimentary rock type with grain sizes of 0.0625–2 mm. The main constituents are quartz, feldspar, mica, and general rock particles, although the proportions of these may vary widely.

sandstorm Phenomenon in which sand and dust particles are uplifted, often to great altitude, by turbulent winds. Visibility is greatly reduced.

sand tiger *See* Odontaspididae.

sandur *See* outwash plain.

sand viper *See Viper ammodytes*.

sand wasps *See* Sphecidae; and Sphecoidea.

sand wave Large-scale, transverse ridge of sand, characteristic of continental-shelf areas such as the S. North Sea. The external morphology is identical to that of the smaller-scale ripple-and-dune bedform (megaripple). The wavelength or spacing of sand wave crests is 30–500 m and the height is 3–15 m. The down-current migration of sand waves leads to the formation of large-scale cross bedding.

sandworts *See Arenaria*.

Sanger's reagent Solution of 1-fluoro-2-4-dinitrobenzene, used for the chromatographic detection and quantification of amino acids, peptides, and proteins. Its effectiveness is based on the reaction of the reagent with free alpha- and epsilon-amino groups to form yellow dinitrophenyl derivatives.

Sansevieria (family Agavaceae) Genus of plants including *S. zeylanica*, which yields bowstring hemp, and *S. trifasciata* (mother-in-law's tongue), a popular house plant with dark green, blotched, strap-like, erect leaves. There are 60 species, found in Arabia, Africa, and Madagascar.

Santalaceae Family of herbs, shrubs, and trees, which are semi-parasitic on roots and stems. The flowers are small and inconspicuous, bisexual or unisexual, with 3–6 fused tepals, the stamens adnate to perianth, and the ovary inferior or semi-inferior. There are 35 genera, with 400 species, occurring in tropical and temperate regions.

Santalum (*Eucarya*, sandalwood; family Santalaceae) Genus of semi-parasitic shrubs and small trees, with opposite, simple leaves which are often linear, and roots that attach to the roots of other plants. The small flowers are held in cymes or panicles, and are green or white in colour. The perianth is four-lobed, and there are four stamens. The fruit is a globular drupe with an outer, succulent, brightly coloured cover over the hard, woody shell that protects the seed. The succulent part of the fruit is edible. *S. spicatum* is one of the fragrant sandalwoods used for incense. *S. album* gives sandalwood oil and is extensively cultivated, especially in India, although it appears not to be native there. The oil is distilled from the wood. There are 25 species, found in SE Asia, the Pacific region, Malesia, and Australia.

sap Exudate from ruptured tissues emanating from the vascular system or parenchyma. *See also* latex; and resin.

sap beetle *See* Nitidulidae.

sapele *See Entandophragma*.

sap-green *See* Rhamnaceae.

Sapindaceae Family mostly of trees and shrubs, with some woody climbers, in which the leaves are pinnate. The flowers are functionally unisexual, but with both sexes variously developed; they are tetra- or pentamerous, with the sepals and petals free, the disc conspicuous, and the ovary superior. There are 150 genera, with 2000 species, occurring in the tropics and subtropics.

sapling Young tree, not yet of useful or timber size, arising from a seed or sucker.

sapodilla plum *See Achras*.

Sapotaceae Family of trees which have white sap. The leaves are spiral and leathery. The flowers are mostly regular with free parts, and the ovary is superior. The fruit is a berry with one or a few big, hard seeds. Many species yield valuable timbers, and some produce useful latex (jelutong, gutta percha). The genera are poorly defined, but there are 35–75 of them, with 800 species, occurring in the tropics and subtropics.

sappan (Brazilwood) *See Caesalpinia*.

sapphire *See* corundum.

saprobe *See* saprotroph.

Saprolegniaceae (order Saprolegniales) Family of fungi, which form a coarse mycelium in which the many nuclei are not separated by septa. There are many genera, found in water, mud, and soil. Some species can cause disease in fish.

Saprolegniales (class Oomycetes) Order of fungi, which are found mainly in aquatic habitats. Most members are eucarpic, although a few are holocarpic. The order includes the large family Saprolegniaceae and several smaller families.

saprolite Chemically rotted rock *in situ*. The term is often applied to the lower portion of a weathering profile. The saprolite on granite is locally called 'grus' or 'growan', although the latter term may include material broken down by mechanical weathering. *Compare* regolith.

sapropelic *See* coal.

saprophage Organism that consumes other, dead, organisms. Saprophages form part of the two-fold division of the heterotrophs (organisms that feed on other organisms), and consist mainly of bacteria and fungi. They break down complex compounds obtained from dead organisms, absorbing some of the simpler products, but releasing most of the products as inorganic nutrients which can then be used by other organisms. *See also* consumer organism.

saprophyte *See* saprotroph.

saprotroph (saprobe, saprovore) Any organism that absorbs soluble organic nutrients from inanimate sources, e.g. from dead plant or animal matter, from dung, etc. If the organism is a plant or is plant-like, it is called a saprophyte; if it is an animal or is animal-like, it is called a saprozoite. *See also* consumer organism.

saprovore *See* saprotroph.

saprozoite *See* saprotroph.

sap stain Stain of the sapwood in freshly-cut timber, caused by any of several types of fungi (e.g. *Penicillium*, *Ceratocystis*, *Cladosporium*). The mechanical strength of the timber is usually little affected.

sapucaia nut *See Lecythis*.

sapwood The active xylem cells, which are peripheral to the dead, woody centre of the trunks of trees. This part of the xylem is distinguished easily from the central heartwood by its colour.

Saraca (family Caesalpinaceae) Genus of small trees in which the young, pinnate leaves hang as pendulous, coloured tassles. The corymbose inflorescences are conspicuous bright yellows or reds, borne on trunks or branches. The sepals form a four-lobed tube, and are apetalous; there are usually 4–8 stamens which are long. The pods are big, flat, and dehiscent. According to tradition the Buddha was born beneath *S. asoca* (asoka). There are eight species of *Saraca*, occurring in tropical forests in India and Malesia.

Sararanga (family Pandanaceae) Genus of trees whose leaves are borne in four spiral ranks, and open sparsely, producing a falsely dichotomously branched crown. The inflorescence is an open, pendulous panicle of small, fleshy, kidney-shaped heads in which the tiny flowers are sunken. There are two species, occurring in the Philippines, New Guinea, the Bismarcks, and the Solomon Islands.

saratoga (*Scleropages leichardti*) *See* Osteoglossidae.

Sarcococca (family Buxaceae) Genus of 16–20 species of subshrubs of the Himalayas, and from China to Indo-Malaysia. Several are cultivated, producing fragrant flowers in winter.

Sarcodina (subphylum Sarcomastigophora) Superclass of protozoa which form pseudopodia for feeding and locomotion. There are three classes, and many orders. The majority of species live in marine aquatic environments, but some occur in fresh water and some are parasitic in the intestinal tracts of vertebrates and invertebrates. The radiolarians are known from the Cambrian, and the heliozoans, which are exclusively freshwater, have a fossil record that extends back to the Pleistocene only.

sarcolemma The plasma membrane of a muscle cell.

Sarcomastigophora (phylum Protozoa) Subphylum of protozoa which can form flagella and/or pseudopodia. Most species are free-living in aquatic environments; some are parasitic in plants and animals.

sarcomere That region of a myofibril of striated muscle that lies between the Z-lines.

Sarcophagidae (flesh flies; class Insecta, order Diptera, suborder Cyclorrapha) Family of flies that was formerly considered by some authors to be a subfamily of the Calliphoridae. Flesh flies are associated with carrion and animal matter since these are the substrates in which their larvae feed. Adults are mainly grey, with marbled abdomens, but are rarely metallic to any extent. The arista of the antennae are plumose on the basal half only. Many species are distinguished only by the male genitalia. The female of the common *Sarcophaga carnaria* is larviparous (deposits larvae rather than eggs). The larvae are well adapted to their mode of life, with rear spiracles set in a deep pit, the edges of which have flexible, fleshy lobes which can be used to seal off the spiracles. This is necessary when the larvae liquefy their carrion and are in danger of drowning. As the larva feeds, the fleshy lobes around the rear spiracles act as floats, allowing it to breathe. The pupa is formed inside the cuticle of the final instar larva (puparium). Escape from the puparium is effected by an inflatable sac (ptilinum) on the head of the fly. This also helps in forcing a path through the pupation medium, which is often soil. More than 1600 species are known to exist.

Sarcophilus harrisi (Tasmanian devil) *See* Dasyuridae.

sarcoplasm The cytoplasm of muscle cells, which, although it contains the usual cellular organelles, is largely dominated by the presence of microfibrils.

sarcoplasmic reticulum Network of membranes that run both longitudinally and transversely across

striated muscle cells. Apparently, the longitudinal channels are derived from the endoplasmic reticulum and are not in direct communication with those running transversely (T-system), which are derived from the cell membrane. The function of the sarcoplasmic reticulum is to act as a store for calcium ions (Ca^{2+}) involved in the contractile process.

Sarcopterygii Term used by some taxonomists in grouping together the lobe-finned fish (subclasses Crossopterygii and Dipneusti). Others tend also to include the terrestrial vertebrates (Tetrapoda). *See also* Choanichthyes; and Gnathostomata.

Sarcostemma (family Asclepiadaceae) Genus of climbing, twining, or erect shrubs, herbs, and some trees, whose leaves are reduced or absent, and whose stems are fleshy. The flowers are bisexual, and usually borne in cymes. The calyx is a fused tube of five segments. The petals are partially fused along their margins and sometimes folded. The five stamens are attached to the base of the corolla-tube. There are 10 species, found in tropical and subtropical parts of the Old World where they are components of xerophytic communities.

sarcotesta *See Calospatha*.

Sargassaceae (order Fucales) Family of brown seaweeds in which the thallus shows monopodial branching, i.e. there is always a distinct main axis. Air bladders are present. Species of the genus *Sargassum* are found in warmer regions and occur in huge floating masses, particularly in the Sargasso Sea. *See also* japweed.

Sargasso Sea Calm centre of the anticyclonic gyre in the N. Atlantic. This large eddy of surface water has boundaries demarcated by major current systems such as the Gulf Stream, Canary Current, and N. Atlantic Drift. The Sargasso Sea is a large, warm (18 °C), saline (36.5–37.0 parts per thousand) lens of water, which is characterized by an abundance of floating brown seaweed (*Sargassum*).

sarmentose Applied to a stoloniferous, straggling shrub.

Sarotherodon *See* Cichlidae.

Sarotherodon mossambicus (cichlid) *See* buccal incubation; and Cichlidae.

sarsen Boulder or block of sediment consisting of a siliceous cement binding one of a range of materials, and found widely in SE England, especially in the chalk country. Typical cemented components include angular quartz grains and rounded to angular flints (the 'Hertfordshire puddingstone'). Sarsens are of early Tertiary age, and probably formed as a duricrust under tropical conditions.

sarsparilla *See Smilax*.

sassafras 1 (Australian (New South Wales), *Doryphora sassafras*) *See Doryphora*. 2 (southern) *See Atherosperma moschatum*.

satellite sounding Remote sensing of atmospheric properties by orbiting Earth satellite. For example, indirect sensing is carried out by spectral analysis of outgoing long-wave radiation with infra-red photography of clouds and determination of cloud-top height from the temperature variations.

satellite virus Abnormal virus that cannot replicate in a host cell by itself, but requires the presence of a second 'helper' virus.

satiation Process that leads to the cessation of an activity, applied most commonly to feeding behaviour. Satiation may be associated with physiological changes and it occurs before the point at which appetite is satisfied completely and continuation of the activity becomes physically impossible.

satin spar *See* gypsum.

satinwood *See Chloroxylon*.

saturated adiabatic lapse rate (SALR) The adiabatic cooling rate of a rising parcel of air which is saturated, and in which condensation is taking place as it rises, when the energy release of the latent heat of vaporization moderates the adiabatic cooling. The reduction of the rate of cooling below the dry adiabatic lapse rate of 9.8 °C/km varies with temperature. This results from greater energy release by condensation from air at higher temperatures. Thus at a given atmospheric pressure, air at 20 °C may have an SALR as low as 4 °C/km, whereas at −40 °C the SALR may be close to 9 °C/km. The stability or instability of the atmosphere at any given time for vertical motion is determined by whether the environmental lapse rate of temperature within it is less than or greater than the adiabatic lapse rate (i.e. less than or greater than the rate of decrease of temperature of rising parcels of air). *See also* dry adiabatic lapse rate; instability; and stability.

saturated air Air that contains the maximum amount of water vapour that is possible at the given temperature and pressure, i.e. air in which the relative humidity is 100%.

saturated flow The movement of water through a soil that is temporarily saturated. Most of the loosely held water moves downward, and some moves more slowly laterally.

saturation deficit At a given temperature, the difference between the actual vapour pressure of moist air and the saturation vapour pressure.

saturn butterflies *See* Nymphalidae.

Saturniidae (atlas moths, emperor moths, moon moths; order Lepidoptera) Family of large to very large moths with characteristic eye-spots on the forewings and hindwings. The wings are very broad, the antennae are bipectinate in both sexes, and the proboscis is absent. Larvae bear fleshy protuberances called scoli, and have hairs and spines. The cocoon is dense. Distribution is worldwide but primarily tropical.

Satyrinae (browns, satyrs, morpho butterflies, heaths, graylings, marbled whites; order Lepidoptera, family Nymphalidae) Subfamily of small to medium-sized butterflies, which are mostly brown, or orange and black, with eye-spots on the wings. The bases of the wings are often swollen. The butterflies are generally shade-loving. The larvae

have a pair of short points at the anal end. Most larvae feed on grasses and sedges. The subfamily is distributed worldwide.

satyrs *See* Satyrinae.

Sauria (Lacertilia, lizards; order Squamata) Suborder of reptiles the more primitive of which are four-legged, terrestrial or arboreal forms, but limbless burrowing species have evolved in many families. The skin is generally shed in pieces. Autotomy (tail shedding and regeneration) is common. Lizards appeared and began to diversify in the Triassic. Their Jurassic history is poorly known, and except for remains of the sea-lizards, e.g. the mosasaurs, this is also true of much of the Cretaceous. However, from the late Cretaceous onwards continental deposits become more frequent again, and have yielded sufficient lizard fossils to trace the development of the group up to the present day. There are 18 extant families, found in all but the coldest parts of the world.

Saurida undosquamis (grinner) *See* Synodontidae.

Saurischia The 'lizard-hipped' dinosaurs, one of the two dinosaur orders. They included bipedal carnivores (Theropoda) and herbivorous tetrapods (Sauropoda). The theropods produced the largest known terrestrial carnivores, and the sauropods yielded the largest known land animals.

Sauropoda Jurassic and Cretaceous quadripedal dinosaurs of herbivorous habit. They included *Diplodocus*, from the Upper Jurassic, one skeleton of which is the longest known of any terrestrial animal, measuring 26.6 m. *Apatosaurus* (*Brontosaurus*) was also a sauropod, and although shorter than *Diplodocus* its skeleton was more massively built.

Sauropodomorpha Suborder of the saurischian dinosaurs, comprising the infra-orders Prosauropoda and Sauropoda. They range from the Middle Triassic to the end of the Cretaceous.

Sauropterygia (subclass Archosauria) Extinct reptilian order, comprising the suborders Plesiosauria (plesiosaurs) and Nothosauria (nothosaurs).

saury *See* Scomberesocidae.

savannah Extensive tropical vegetation dominated by grasses with varying admixtures of tall bushes and/or trees in open formation. Savannah occurs in diverse tropical environments, although most experience a dry season. Much savannah is no doubt climatic climax, although extensive tracts are anthropogenic fire climaxes, and it is generally difficult to distinguish the one type from the other.

savannah woodland Savannah in which trees and shrubs form a generally light canopy. The trees and bushes are generally deciduous, yet evergreens are usually also well represented. Some tall trees occur, but most are stunted and gnarled. They frequently have thick, corky, fire-resistant bark.

sawbills *See Mergus*.

sawfish *See* Pristidae.

sawflies *See* Hymenoptera; Symphyta; Tenthredinoidea; and Tenthredinidae.

saw sedge (*Cladium mariscus*) *See Cladium*.

sawshark *See* Pristiophoridae.

Saxegothaea (family Podocarpaceae) Genus of one species, *S. conspicua*, an evergreen, coniferous tree confined to Chile, which has two-ranked, yew-like foliage. Female cones have fleshy, overlapping, prickly scales. It is just hardy in Britain.

Saxicola (chats; family Turdidae) Genus of small, mainly brown, or black and white birds, which have small, fine bills, and rounded heads. They inhabit open, bushy country; feed mainly on insects; and nest on the ground or in rock crevices. There are 10 species, many migratory, found in Europe, Africa, Asia, and Indonesia. *S. rubetra* (whinchat) migrates from Europe to Africa.

Saxicola rubetra (whinchat) *See Saxicola*.

saxicolous Growing on stones, rocks, walls, etc.

Saxifragaceae Family of herbs, in the narrower sense consisting of plants with usually alternate leaves, and regular, tetra- or pentamerous flowers, with free petals and usually eight or 10 stamens. There are two carpels, normally united at the base and free above, seated in a receptacle cup. *Saxifraga* (saxifrage) contains more than 300 species, mostly small, often mat-forming herbs, mostly of alpine or arctic distribution, many of which have attractive flowers and are much grown in rock gardens. As usually understood, the family contains some 35 genera, with 500 species, of cosmopolitan but largely temperate distribution; but in some modern classifications it includes the previously separate families Grossulariaceae (one genus), Parnassiaceae (one genus, with 45 species), Hydrangeaceae (15 genera, with 200 species), and Escalloniaceae (20 genera, with 150 species).

Sayornis (phoebes; family Tyrannidae) Genus of medium-sized, brown, or black and white flycatchers, with longish tails that are constantly flicked downwards. They are found near water, perching in the open to feed on insects. They nest under overhanging banks or in buildings. There are three species, two of them migratory, found in N., C., and S. America.

scab General term for any plant disease in which the symptoms include the formation of dry, corky scabs. Examples include apple scab and potato scab. *See also Streptomyces*.

scabrous Rough-surfaced; bearing short, stiff hairs, scales, or points.

scad *See* Carangidae.

Scadentia (tree shrews) *See* Insectivora; and Proteutheria.

Scaevola (family Goodeniaceae) Genus mostly of shrubby trees, with some herbs, in which the flowers are zygomorphic with the corolla tube split to the base on the top side. The fruit is a berry. There are 80–100 species, occurring in the tropics and subtropics, and especially in Australia.

scaled blennies *See* Clinidae.

scale insect *See* Coccidae.

scaleworms *See* Errantia.

scaly ant-eater *See* Manidae.

scaly dragonfish (*Stomias boa*) *See* Stomiatidae.

scaly-tailed squirrel *See* Anomaluridae.

scaly wearyfish (*Scopelosaurus harryi*) *See* Scopelosauridae.

scampi *See Nephrops norvegicus*.

scampo *See Nephrops norvegicus*.

Scandentia *See* Insectivora.

Scapania (order Jungermanniales) Large genus of leafy liverworts, in which the thallus is small to large and robust. The leaves occur in two ranks; each leaf is divided into two lobes, the smaller lobe being folded back over the larger, posterior one and appearing at first sight to be a separate leaf. They are found on rocks, on peat, on tree roots, etc., generally in moist, shady, non-calcareous habitats.

scape 1 (entomol.) The usually elongate basal segment of geniculate (elbowed) antennae in Hymenoptera (bees, wasps, and ants). 2 (bot.) Leafless flower stalk, e.g. in plantain.

Scaphopoda (tooth shells, tusk shells; phylum Mollusca) Order of elongate, bilaterally symmetrical, burrowing, marine molluscs which have a tapering shell open at both ends, the larger, apertural end being anterior. Most are also curved, with the convex side ventral. The shell is secreted by the mantle and composed of three distinct layers of calcium carbonate. Most individuals are 2–5 cm long. The head contains the mouth with a radula, surrounded by food-gathering appendages. There are no eyes. The mantle cavity contains paired kidneys, a liver, a simple stomach, a heart, and a solitary gonad. The nervous system is ganglionic, and there are no gills. The blood-filled foot is used for burrowing. The order contains two families. Scaphopoda are thought to have first appeared in the Devonian, but some have been tentatively reported from the Ordovician in Russia.

scapula 1 In tetrapods, the dorsal part of the pectoral girdle. 2 In Mammalia, the shoulder blade.

scar (geomorph.) Steep, cliff-like slope of bare rock, developed in the near-horizontally bedded Carboniferous limestone of the Yorkshire Dales, England. The steepest and highest scars are normally associated with the outcrop of the purest and most massively bedded limestone. Often a scree is formed at the base.

scarab *See* Scarabaeidae.

Scarabaeidae (scarabs, chafers, tumblebugs; class Insecta, order Coleoptera) Family of beetles, which are very diverse in form and habit, and are 2–150 mm long. The antennal club consists of movable, flattened plates. Chafers (e.g. *Melolontha melolontha*, the Maybug or cockchafer) are nocturnal. Adults are leaf feeders, often pests. Larvae are C-shaped, fleshy, and feed on roots, often taking up to three years to develop. Dung rollers (e.g. *Scarabaeus sacer*, the sacred scarab) have front legs without tarsi, specialized for forming the dung ball that is rolled to an underground chamber to feed larvae. Some species remain with their young until these are mature. Cetoniines (rose beetles) are large, brightly coloured, and diurnal (e.g. *Goliathus giganteus*, Goliath beetle, which is up to 150 mm). Larvae are found in decaying plants; adults feed mostly on fruits or flowers. Dynastines, the rhinoceros beetles (e.g. the elephant beetle and Hercules beetle) are virtually all tropical. Adults are dark, shiny, and nocturnal, with large curved horns on the head and thorax of males. Some larvae are pests of sugarcane and palm trees. There are 17 000 species.

Scarabaeus sacer (sacred scarab) *See* Scarabaeidae.

Scaridae (parrotfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Fairly large family of colourful marine fish with an oval-shaped body, a continuous dorsal fin, and large scales; and with the teeth in both jaws fused into a strong cutting edge, resembling the beak of a parrot. This 'beak' is used to scrape off algae and other plant material from rocks and corals. Active during the day, parrotfish have been observed to sleep or rest during the night. Like the related wrasses (Labridae), colour patterns can change during the day and may differ between the sexes. One of the larger species is *Scarus coeruleus* (blue parrotfish), 1.2 m, found in the W. Atlantic. There are about 68 species, distributed worldwide in tropical to temperate waters.

scarious Dry and membranaceous.

scarlatina *See* scarlet fever.

scarlet elf-cup Common name for the apothecium of *Sarcoscypha coccinea* (order Pezizales), which is cup-shaped, up to 4 cm across, scarlet inside, and white outside. It is found on fallen sticks or branches in winter.

scarlet fever (scarlatina) Acute, infectious disease which affects mainly children; the causal agent is *Streptococcus pyogenes*. Symptoms include sore throat, fever, and typically a characteristic rash on trunk and limbs.

scarlet macaw (*Ara macao*) *See Ara*.

scarp (abbr. of escarpment) Steep slope or cliff found at the margin of a flat or gently sloping area. Many varieties are recognized, and distinguished in terms of origin. A 'fault scarp' results when a fault displaces the ground surface so that one side stands high. A 'fault-line scarp' is produced by erosion on one side of an ancient fault: obsequent and resequent varieties are recognized. A 'composite fault-line scarp' results from a combination of erosion and faulting. Erosional scarps result from vertical incision, or from the headward enlargement of pediments.

Scarus coeruleus (blue parrotfish) *See* Scaridae.

scat *See* Scatophagidae.

Scatophagidae (scat, butterfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of coastal fish, members of which frequently penetrate into fresh water. They have a deep body, two separate dorsal fins, and, typically, four spines in the anal fin. *Scatophagus argus*

(spotted butterfish or spotted scat), 32 cm, is a fairly common species in the Indo-Pacific region. There are three species.

Scatophagus argus (spotted butterfish, spotted scat) *See* Scatophagidae.

scattering Diffusion of incident radiation by atmospheric particles, e.g. by haze and water droplets as well as by molecules. Such diffused radiation is often refracted many times in passing through the atmosphere. *See also* Mie scattering; and Rayleigh scattering.

scavenger *See* detritivore.

scavenging The capture and removal by rain or snow of particulate matter in the atmosphere.

SCE *See* sister chromatid exchange.

Scelidosaurus harrisoni Small (3.7 m long) ornithischian (bird-hipped) reptile whose body was covered with small, bony plates. It is known from the Lias (Lower Jurassic) of England and is the likely ancestor for the armoured stegosaur and ankylosaur dinosaurs.

Scelionidae (suborder Apocrita, superfamily Proctotrupoidea) Family of minute (usually 2 mm long or less) egg parasites, black or rarely brown in colour, whose abdomens are generally flattened, with sharp lateral margins. The antennae are elbowed or bent, arise low on the face, and are 11- or 12-segmented, with a club. The wing venation is greatly reduced. The larvae are mainly egg parasites, some particularly on grasshoppers and mantids, but the majority parasitize eggs of Lepidoptera, Hemiptera, and Coleoptera. The adult female often clings to the host until eggs are laid, whereupon she dismounts and deposits her own eggs. The family is large and common.

Scenedesmus (order Chlorococcales) Genus of green algae in which the cells occur adjacent to one another in coenobia, the number of cells per coenobium being a multiple of two, typically four or eight. Sometimes they are placed in a separate family, Scenedesmaceae; sometimes they are included in the family Oocystaceae. They are very common in all types of aquatic habitat.

scent brush Eversible structure found on the abdomen of a member of the Lepidoptera: it is brush-like and contains a great deal of glandular twine. Scent brushes disperse pheromones.

scent marking The use by an animal of scented secretions, faeces, urine, or saliva as a means of communication: the substance is deliberately placed on the ground, on an object, or on another animal.

scheelite Mineral, specific gravity 5.9–6.1, hardness 4.5–5.0, and with the chemical composition $CaWO_4$, named after the eighteenth-century Swedish chemist K. W. Scheele. It occurs in pegmatite veins and in high-temperature mineral veins, and is often in association with wolframite, cassiterite, molybdenite, fluorite, and topaz. It is also found in contact metamorphic zones together with axinite, garnet, wollastonite, and metamorphic calcium minerals. It is distinguished by its bipyramidal habit, high specific gravity, and fluorescence. It is white, or sometimes shades of yellow, green, brown, or red, and has a white streak and a vitreous lustre. It crystallizes in the tetragonal system. The crystals are usually bipyramidal, and it is also massive and granular. It is one of the chief ores of tungsten.

Schiff's reagent Reagent consisting of fuchsin bleached by sulphurous acid that produces a red colour upon reaction with an aldehyde.

Schilbeidae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater catfish which have a scaleless, elongate body, strongly tapering towards the tail. They have a short dorsal fin, but a long-based anal fin and four pairs of barbels around the mouth. Some species, e.g. *Schilbe mystus* (40 cm) are of some local importance as food fish. There are about 40 species, in African and Indian waters. *See also* Pangasiidae.

Schindler fish *See* Schindleriidae.

Schindleriidae (Schindler fish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of small fish, about 3 cm long, which have a scaleless and transparent body. All the fins are very small and the pelvic fins are lacking. Probably fairly abundant, *Schindleria praematurus* is found in surface waters of the Pacific Ocean.

schist Rock, formed by regional metamorphism, which has a schistosity. Schists are coarser-grained than phyllites and the minerals producing the schistosity may be mica or amphibole, depending on the composition and the pressure and temperature of formation.

Schistocerca gregaria (red locust) *See* locust.

schistosity Textural term applied to metamorphic rocks that have a strongly parallel arrangement of certain minerals, usually the micas or amphiboles.

schistosomiasis (bilharzia) Any one of a group of diseases of humans and some other Mammalia caused by infestation by blood flukes, Trematoda of the genus *Schistosoma*. The trematode requires two hosts, the first being an aquatic snail in which larvae emerging from eggs hatched in water develop through several stages, finally to fork-tailed forms (cercariae) which escape from the snail, swim freely in the water, and attach themselves to, and penetrate, the skin of their second host, a mammal. In the mammalian body they move through blood vessels, feeding upon glycogen in the blood plasma and growing, eventually migrating to a site that varies from species to species, where they mature, mate, and lay eggs. These eggs leave the body in urine or faeces. Symptoms vary according to the species causing the infestation, but may include swelling and tenderness of the liver, dropsy, enlargement of the spleen, watery skin eruptions, fever, cough, haemorrhage, diarrhoea, and reduced function of the affected organs. The diseases are common in low latitudes.

Schistostegales (subclass Bryidae) Order of mosses, in which the protonema is persistent and unique in structure; it has light-refracting properties and appears almost luminous. The leaves of the sterile

shoots are arranged in two ranks and are nerveless. The capsule lacks a peristome. There is one genus, and one species, *Schistostega pennata*. Not common in Britain, it is found mainly in habitats with low light levels—caves, rabbit burrows, fissures among siliceous rocks, mineshafts, etc.—particularly in sandstone areas.

Schizaeaceae Family of ferns in which the sporangia are borne naked and singly on the margins of the leaves, sometimes protected by the incurved leaf margin. The sporangia are relatively massive, somewhat intermediate in character between those of eusporangiate and leptosporangiate ferns, with very short, thick stalks, and a terminal ring of thickened cells; they may contain more than 200 spores. All sporangia mature at the same time (simple type of development). The gametophytes are either green and filamentous, like moss protonemata, or (in *Actinostachys*) may be fleshy, subterranean, cylindrical structures with mycorrhizal fungi. There are five genera, mostly tropical, but the family extends into temperate parts of America.

Schizodactylidae (order Orthoptera, suborder Ensifera) Small family of Old World crickets which are carnivorous, and nocturnal, burrowing into the soil during the day. There are three genera : winged forms occur in only one, *Schizodactylus*.

schizodont Applied to a type of hinge dentition, found in certain members of the pelecypod order Trigonioida, in which the teeth are large, and possess parallel ridges at right angles to the axis of the teeth. The left valve bears a single tooth.

schizogony Type of asexual reproduction in which a new generation of feeding cells results from multiple fission of the parent cell.

Schizogregarinida (subclass Gregarinia) Order of protozoa which reproduce asexually by multiple fission (schizogony). They are parasitic on arthropods and other invertebrates.

Schizomeria (family Cunoniaceae) Genus of 18 species of timber trees, which occur from the Moluccas to Queensland and the Solomon Islands.

schizomids *See* Uropygi.

Schizomycetes Out-dated taxon for the bacteria.

Schizophyllaceae (order Aphyllophorales) Family of fungi in which the fruit bodies bear characteristic longitudinally-divided gills. There are several genera. *Schizophyllum commune* forms fan-shaped fruit bodies that are attached on one side to the substrate. It is found on wood and is common in Europe, especially in the south.

Schizothrix (order Nostocales) Genus of sheathed, filamentous cyanobacteria. A single species of *Schizothrix* is responsible for the formation of the gelatinous stromatolites found in the shallow waters of S. Florida and the Bahamas. Some species grow on soil, and in some areas mats of *Schizothrix* filaments play an important role in binding soil particles and preventing erosion.

Schoenus (family Cyperaceae, subfamily Rhynchosporoideae) Genus of perennial herbs with smooth stems, usually found in damp and marshy habitats. Most are tufted. The leaves are basal or restricted to the lower part of the stem and sheathing; the blades of the leaves are narrow, like those of grass. The flowers are small, inconspicuous, and bisexual, and arranged in 1–4-flowered spikelets held in a terminal panicle. The bract of the lowest spikelet encircles the whole base of the inflorescence. The perianth has up to six bristles, and there are three stamens and three styles. The fruit is a three-sided nut. There are about 100 species, found mainly in Australia and New Zealand.

school (shoal) An aggregation of fish which are observed swimming together, possibly in response to a threat from a predator. More strictly, a grouping of fish, drawn together by social attraction, whose members are usually of the same species, size, and age, the members of the school moving in unison along parallel paths in the same direction. Sudden changes at the leading edge of the school are followed almost instantaneously by the remainder of the group, with the fish on the flank becoming the new leaders. In general, the overall size and shape of the school, as well as the cruising depth and speed, vary from one species to another.

schooling Among fish the formation of groups of individuals as a result of social attraction.

Sciadopitys (Japanese umbrella pine; family Pinaceae) Monotypic genus of conifers with the needle-like leaves fused together in pairs throughout their length, and arranged in whorls on the shoots, with scale-like leaves at the bases of the whorls. The genus is native to Japan.

Sciaenidae (drum, meagre; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of mainly marine fish which have an elongate body; two dorsal fins; an anal fin, with two spines, that is much shorter than the second dorsal fin; and a lateral line that continues into the base of the tail-fin. Many species have a swim-bladder which can be used to produce sound. *Argyrosomus regius* (meagre), 1.8 m, is one of the many commercially important species. There are about 160 species, with worldwide distribution in tropical to temperate waters.

sciaphilic (skiaphilic) Shade-loving; growing only in shady habitats.

Sciaridae (European army worm; class Insecta, order Diptera, suborder Nematocera) Family of minute flies which is regarded by some authors as a subfamily of Mycetophilidae. These may be recognized by their characteristic wing venation, with prominent anterior veins, and simple, fine, posterior veins The compound eyes curve to meet one another above the antennae. Some species are sexually dimorphic, the females being normal but the males having greatly reduced wings. The larvae often move *en masse*, a phenomenon that gives them their common name More than 1200 species have been described. *See* Mycetophilidae.

scimitarbills (*Rhinopomastus*) *See* Phoeniculidae.

Scincidae (skinks; order Squamata, suborder Sauria (Lacertilia)) Family of terrestrial and burrowing lizards, in which the head is wedge-shaped, the body streamlined and elongate, and the limbs small or absent. The scales are smooth, often overlying small osteoderms. The teeth are pleurodont. The tongue is slightly notched. Skinks' diet is mainly insectivorous, but Australian tiliquine skinks are vegetarian. There are more than 800 species, occurring in the subtropics and in desert regions throughout the world. *See Tiliqua rugosa*.

scion *See* graft.

scirocco (sirocco) Regional term for one of the genera of warm winds from south of the Mediterranean. It moves ahead of an eastward-travelling depression and brings hot, dry, dusty conditions to Algeria and the Levant. To the north, where its humidity increases very rapidly as it crosses the sea, it brings moist air to the coast of Europe.

Scirpus (club rush; family Cyperaceae, subfamily Scirpoideae) Genus of rhizomatous, perennial, grass-like herbs which have solid, often three-angled stems. The leaves usually arise from the base with a closed stem sheath and grass-like blade with no ligule. The inconspicuous flowers are bisexual and borne in spikelets of two to many. They are held in a terminal, branched inflorescence. The perianth is a series of bristles or scales, and there are three stigmas. The ovary is superior. There are about 40 species, found throughout the temperate regions of the world; about 17 are endemic to Australia. Most species occur in marshland and several are used in medicine. *S. lacustris*, the true bulrush of the northern hemisphere, is used for basketwork.

Scirpus lacustris (bulrush) *See Scirpus*.

Sciuridae (squirrels; order Rodentia, suborder Sciuromorpha) Family of diurnal, mainly arboreal but also terrestrial or burrowing rodents, in which the tail is fully haired and often bushy; there are four digits on the forelimbs and five on the hind limbs, all with sharp claws; and the eyes and ears are relatively large. The cheek teeth are low crowned and lophodont. They are distributed widely in Eurasia and N. America, but do not occur in Australasia or Madagascar. In addition to the familiar arboreal squirrels, e.g. *Sciurus vulgaris* (red squirrel of Eurasia) and *Petaurista alborufa* (red-and-white giant flying squirrel of S. Asia), the family includes ground squirrels, e.g. *Tamias* and *Eutamias* (N. American chipmunks), *Cyomys ludovicianus* and *C. leucurus* (prairie dogs of N. America), and *Marmota marmota* (marmot or woodchuck). Squirrels reached S. America during the Pleistocene but are not found in the southern part of the continent. There are 47 genera, with about 250 species.

Sciuromorpha (Protrogomorpha; cohort Glires, order Rodentia) Suborder comprising the more primitive rodents, in which the masseter muscle is attached mainly at the lower edge of the zygomatic arch; and more advanced forms, placed in the family Sciuridae, in which the middle masseter is attached at the outside of the skull in front of the orbit. The suborder includes 13 families of beavers, squirrels, marmots, and gophers. Some authorities prefer the term 'Protrogomorpha', which indicates the primitive level of development of members of the suborder, the sciurids being specialized forms rather than central to the group.

Scleractinia Alternative name for the anthozoan order Madreporaria.

Scleraxonia (order Gorgonacea) Suborder of octocorals in which the central axial skeleton is formed from spicules bound together more or less solidly by either horny or calcareous material. The suborder includes *Corallicum* (red or precious coral) among its 26 genera in seven families.

sclerenchyma The fibrous or woody tissue in a plant that provides mechanical support for the plant. It is formed from cells whose walls are thickened with cellulose or lignin, and when mature the cells usually contain no living protoplasm. The cells may occur singly or in groups and may be long and fibrous or stony. Stone cells (sclereids) are found in seed coats and some fruits (e.g. pears).

sclerite One of the stiff, sclerotized, cuticular elements from which the exoskeleton of an insect is constructed. The sclerites are connected to one another by flexible cuticular membranes.

scleroblast In Porifera, a structure formed by the partial fusion of amoeboid cells (sclerocytes), which then separates again, its members secreting one of the spicules from which the skeleton of the sponge is composed.

Scleroderma (order Sclerodermatales) Genus of fungi, in which the more or less spherical fruit bodies consist of spore-forming tissue enclosed by a tough, single-layered peridium. The spores are spiny or reticulate and are released only on decay of the peridium. There are many species, found in autumn growing under trees in heathland or woodland. *See also* earth ball.

Sclerodermatales (class Gasteromycetes) Order of fungi, in which the fruit body occurs on or below ground and is typically more or less spherical (but may resemble an earth star). Spores are released via splits in the peridium.

Sclerodermi Older name for the filefish and triggerfish now included in the order Tetraodontiformes.

Scleropages leichardti (barramundi, saratoga) *See* buccal incubation; and Osteoglossidae.

Scleroparei Older name for a group of fish now included in the order Scorpaeniformes.

sclerophyllous vegetation Typically scrub, but also woodland, in which the leaves of the trees and shrubs are evergreen, small, hard, thick, and leathery. These adaptations allow the plants to survive the pronounced hot, dry season of the Mediterranean-type climate in which sclerophyllous vegetation is best developed.

scleroprotein One of a group of insoluble, fibrous proteins, which serve as structural materials within the body. The group includes the collagens and keratins.

Sclerotinia (family Sclerotiniaceae, order Helotiales) Genus of fungi which live parasitically on a range of higher plants. Stalked apothecia develop from stromata which grow in the tissues on an infected plant. *S. fructigena* causes brown rot in apples and certain other fruits.

Sclerotium (class Hyphomycetes) Form-genus of fungi which have perfect states classified in either the Basidiomycotina or the Ascomycotina. *S. cepivorum* causes the disease 'white rot' of onions; this species produces hard, resistant sclerotia which can remain in the soil for long periods of time.

sclerotium Fungal resting body which is resistant to unfavourable environmental conditions and which can remain dormant for long periods of time.

scolex In Cestoda, the anterior end, which bears the hooks and suckers by which the animal is attached to its host.

scoli *See* Saturniidae.

Scoliidae (suborder Apocrita, superfamily Scolioidea) Family of hymenopterans in which most adults are orange-yellow with golden hairs, or occasionally dark; they can usually be found on flowers. They are large (9–36 mm long, most being 20–30 mm), robust, and densely hairy, and are parasitic on scarab larvae in the soil. The hosts are insensitized and eggs are laid externally on the abdomen. Sexual dimorphism is often marked.

Scolopacidae (sandpipers, curlew, snipe; order Charadriiformes) Family of small to large wading birds, most of which are cryptically patterned with brown, grey, black, and white plumage. Their bills are short to long, straight, and decurved or recurved. Their necks are medium to long, their wings long, and their legs short to long. They inhabit open areas, usually near water, flocking in coastal areas outside the breeding season. They feed on invertebrates, and usually nest on the ground. There are 23 genera, with 85 species, found worldwide.

Scolytidae (bark beetles; class Insecta, order Coleoptera) Family of small, dark, cylindrical beetles, usually less than 5 mm long, in which the head is hooded by a large pronotum. The antennae are short and clubbed. The elytra are often incised and grooved behind, producing a device that enables them to shovel wood debris. An egg chamber is excavated under bark or deeper in wood according to species; eggs are placed in separate niches. Larvae are fleshy and legless, and tunnel away from the main chamber producing a characteristic pattern. Dutch elm disease is caused by a fungus carried by the elm bark beetle, *Scolytus scolytus*; the fungus blocks tree vessels. Ambrosia beetles (e.g. *Xyleborus* species) penetrate wood, but larvae feed on fungi which develop on tunnel walls.

Scolytus scolytus (elm bark beetle) *See* Scolytidae.

Scomberesocidae (saury, skipper; class Osteichthyes, subclass Actinopterygii, order Atheriniformes) Small family of marine, pelagic fish with a very slender body, produced and beak-like jaws, and with the dorsal and anal fins located near the tail-fin and followed by a series of small finlets. Where locally abundant, they are exploited commercially, and they may well be an important source of food for larger predatory fish. *Scomberesox saurus* (skipper or Atlantic saury), 46 cm, may occur worldwide in the warmer seas. *Cololabis saira* (Pacific saury), 36 cm, appears to be distributed in the Pacific basin. There are about four species.

Scomberesox saurus (skipper, Atlantic saury) *See* Scomberesocidae.

Scomber scombrus (Atlantic mackerel) *See* Scombridae.

Scombridae (tuna, mackerel; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine, pelagic fish, found in warm to temperate waters and often having perfectly streamlined, spindle-shaped bodies. There are two widely separated dorsal fins; the second dorsal and the anal fin are each followed by a series of small finlets. The narrow caudal peduncle bears a strongly forked or lunate tail-fin. The Scombridae are all fast-swimming, predatory fish; and many species are much sought-after, commercially important fish, e.g. *Thunnus thynnus* (Atlantic tuna), 4.8 m, *Thunnus alalunga* (albacore), 1.2 m, and *Scomber scombrus* (Atlantic mackerel), 56 cm. There are about 45 species, distributed worldwide.

scopa Specialized tract of hairs between which female bees compact pollen for transport back to the nest. In solitary mining bees the principal scopa comprises plumose (branched) hairs on the hind legs and can be massively developed. Some mining bees have additional scopae on the under-side of the first abdominal (metasomal) sternite. The families Fideliidae and Megachilidae have well-developed scopae on the ventral surface of the abdomen and these comprise dense fringes of stiff, straight or microscopically coiled hairs. Pollen scopae are absent in cuckoo bees, which do not forage for themselves.

Scopelarchidae (pearleye; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine, mid-water fish, with an elongate body, a large mouth, large, upward-directed eyes, and the small dorsal fin followed by an adipose fin. Some species, e.g. *Benthalbella dentata* (23 cm), which can be found at depths of more than 1000 m, have a large, glistening spot near the eyeball. There are 18 species, distributed worldwide.

Scopelomorpha Superorder of bony fish including the order Myctophiformes.

Scopelosauridae (Notosudidae; wearyfish; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Small family of marine fish which have a thin, slender body, large eyes and large mouth, and a single dorsal and an adipose fin above the anal fin. *Scopelosaurus harryi* (scaly wearyfish), 22 cm, and its relatives are probably inhabitants of deep seas. There are about five species, distributed worldwide.

Scopelosaurus harryi (scaly wearyfish) *See* Scopelosauridae.

Scophthalmus maximus (European turbot) *See* Bothidae.

Scopidae (hammerhead; order Ciconiiformes) Monotypic family comprising *Scopus umbretta*, a medium-sized, brown bird with a large head and a long neck crest, a long, stout bill, long wings, and a long tail. Its legs are fairly long, with partially webbed toes, the middle one being pectinate. It inhabits marshes and streams near trees, feeds on amphibians, fish, and insects, and builds a large, roofed nest in a tree. It is found in Africa.

scops owls *See Otus*.

Scopus umbretta (hammerhead) *See* Scopidae.

scoriaceous *See* amygdale.

Scorodocarpus (family Olacaceae) Genus of one species, a big rainforest tree which produces a hard timber suitable for construction. It is notable for the powerful reek of garlic from all parts, sometimes at 20 m distance without the tissues having been damaged. It occurs in Sumatra, Malaya, and Borneo.

Scorpaenidae (scorpionfish, rockfish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Very large family of bony fish which have moderately compressed bodies, large heads with prominent eyes, and with a bony ridge or stay across the cheeks. The gill cover is usually protected by a number of sharp spines. The pelvic fins are placed far forward under the fan-like pectoral fins. Scorpionfish are bottom-dwellers and poor swimmers. Although many species have intricate colour patterns, few can match the striking appearance of *Pterois volitans* (lionfish), 30 cm. Like most scorpionfish, the lionfish has venom glands at the bases of the fin spines and can inflict very painful stings. However, many species are quite edible and several, e.g. *Sebastes marinus* (ocean perch), 60 cm, are harvested commercially. There are about 330 species, distributed worldwide in tropical and temperate seas.

Scorpaeniformes Order of bony fish, which are distinguished by the presence of a bony ridge or stay across the cheeks, rounded pectoral fins, and spiny projections on the gill cover. Most species are bottom-dwellers, with intricate colour patterns used to conceal the fish. The order includes 21 families, including Cottidae (sculpins), Scorpaenidae (scorpionfish), and Triglidae (gurnards).

scorpioid cyme Type of cyme in which the axis is curved or coiled (like the tail of a scorpion) and the flowers open successively downwards from the apex, always on one (the convex) side of the axis.

Scorpiones (scorpions; class Arachnida) Order of what are considered to be the most primitive arachnids, which have retained the division and segmentation of the abdomen. Scorpions have changed little since the Silurian. The prosoma is covered by a carapace and broadly joins the segmented abdomen, which is divided into a wide, anterior mesosoma (pre-abdomen), and a long, posterior metasoma (post-abdomen). The latter consists of a series of ring-shaped segments terminating in a telson in the form of a sting with associated poison glands. The chelicera are very small, and the pedipalps are armed with large pincers. Scorpions are usually yellow to brown or black, more rarely greenish or bluish, and all fluoresce in ultraviolet light. All except cavernicolous species have a pair of median eyes and 2–5 pairs of lateral eyes on the carapace margin. Sensory organs include slit sense organs, sensory setae, and trichobothria, as well as peculiar pectines (comb-like structures with innervated tips) responding to touch and vibration frequencies above 100 Hz. Most sting in defence or to subdue struggling prey, and although the poison may be strong and even effective against vertebrates, they themselves are immune. Members of the family Buthidae are dangerous to humans, the poisons being neurotoxic in action. Mating involves the deposition of a spermatophore by the male, and an often lengthy and complex courtship ending with the female being led and pulled over the spermatophore, whereupon she takes the apical portion into her gonopore. Members of the Scorpionidae are viviparous, and as in all arachnids there is a high degree of parental care. Most of the 700 or so known species, distributed among six families, are tropical and subtropical, but the European species *Euscorpius germanus* is found in the S. Alps, and *E. flavicaudis* has been found in Kent, England. The largest known species is the African *Pandinus imperator*, which reaches 170 mm in length.

scorpionfish *See* Scorpaenidae.

scorpions *See* Arachnida; and Scorpiones.

scoters *See Melanitta*.

scow Unit of measurement of tree bark.

scrapie Disease which affects mainly sheep. Infected animals show signs of severe itching and loss of co-ordination of movements. The causal agent is believed to be a virus.

screamer *See* Anhimidae; and Anseriformes.

screaming cowbird (*Molothrus rufoaxillaris*) *See Molothrus*.

scree Accumulation of coarse rock debris that rests against the base of an inland cliff. It is added to by the weathering and release of fragments from the cliff face. Screes are widely found in upland areas that are affected by past or present periglacial conditions, and in hot, rocky deserts.

screech beetle *See* Hygrobiidae.

screech owls *See Otus*.

screw pines *See Pandanus*.

Scrophulariaceae Family of dicotyledonous herbs, with a few shrubs and trees. It shows great variation, but all its members have more or less irregular flowers, usually distinctly two-lipped, or sometimes with flat corollas with four unequal lobes (e.g. *Veronica*). There are usually four stamens, rarely five (e.g. *Verbascum* and *Pentstemon*), or sometimes only two (e.g. *Veronica*). The ovary is distinctive. It is superior, of two cells joined together, with axile placentation and a terminal

style that is simple or bilobed. The fruit is normally a capsule, rarely a berry, and the seeds are numerous in each capsule cell. Genera such as *Antirrhinum*, *Calceolaria*, *Digitalis*, *Mimulus*, *Verbascum*, and *Veronica* have flowers attractive enough to be garden favourites, and *Digitalis* (foxglove) is the source of an important heart stimulant, but otherwise the family is of little economic importance. There are more than 200 genera, with 2500 species, of cosmopolitan distribution.

scrotum In male Mammalia in which the testes descend from the abdomen, the sac in which they are contained at least during the breeding season and in which they are maintained at a temperature lower than the body temperature.

scrub-birds *See* Atrichornithidae.

scrubfowl *See Megapodius*.

scrub typhus (Tsutsugamushi disease) Acute, infectious disease of humans which occurs mainly in SE Asia, Japan, and N. Australia. Symptoms are similar to those of classical typhus. The causal agent, *Rickettsia tsutsugamushi*, is transmitted by mites. Rodents provide a reservoir of infection.

scrub vegetation General term for vegetation dominated by shrubs, i.e. low-stature woody plants, which typically forms an intermediate community between grass or heath and high forest. Successional change is not necessarily implied though the term is often used for the transitional stage in succession to climax woodland when shrubby plants predominate.

scrub wrens *See* Acanthizidae.

Scrupariina (order Cheilostomata, suborder Anasca) Division of cheilostome bryozoans, in which the colony has an erect, upstanding habit. The individuals are tubular, and growth is uniserial. The division occurs from the Cretaceous to Recent.

scud Popular term for *stratus fractus* (fractostratus), a fragmented low cloud moving quickly beneath rain clouds.

sculpin *See* Cottidae; and Icelidae.

Scutellina (order Clypeasteroida) Suborder of sand-dollars characterized by a more or less flattened shape, and the development of food grooves on the ambulacra. Several genera develop holes (lunules) passing through the test. The Scutellina first appeared in the Lower Eocene.

scutellum The most posterior of the three dorsal sclerites that are found on the mesothorax and metathorax of many winged insects.

scute In fish, an enlarged, bony, dermal plate or scale.

scuttle flies *See* Phoridae.

scutum 1 In Cirripedia, one of the two plates covering the anterior end of the sides of the mantle. 2 In insects, the middle of the three divisions of the dorsal surface of a thoracic segment.

Scyliorhinidae (catshark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Family of marine sharks with slender bodies and the first of the two dorsal fins usually situated over or behind the ventral fins. There is no nictitating membrane or oro-nasal groove. The anal fin is present. Catsharks, e.g. *Scyliorhinus caniculus* (lesser spotted catshark), 80 cm, tend to be bottom-dwelling, slow-moving sharks feeding on small animals. Their eggs are enclosed in horny capsules which are often attached to seaweed. There are about 58 species, distributed worldwide in temperate to tropical seas.

Scyliorhinus caniculus (lesser spotted catshark) *See* Scyliorhinidae.

scyphistoma In Scyphozoa, the polypoid larval stage which develops from a planula larva. It produces more scyphostomae by budding and, at certain times of year, produces minute medusae (ephyrae) some of which develop into the sexual adult form.

Scyphomedusae (class Scyphozoa) Subclass of medusoid Cnidaria, whose members lack a velum (a narrow shelf inside the border of the sub-umbrellar cavity) and have a coelenteron partly divided by four interradial endodermal septa. They are first known from Cambrian rocks.

Scyphostegia Genus of one species, the only member of the family Scyphostegiaceae: it is a small, dioecious tree in which the leaves are alternate, with inconspicuous stipules. The flowers are borne in spikes, and are unisexual, with six tepals, the stamens forming a column and the carpels tiny, within an urceolate structure. The fruit is a fleshy capsule. It is a curious family, perhaps related to the Flacourtiaceae. It is endemic to Borneo.

Scyphozoa (jellyfish; phylum Cnidaria) Class of marine, mainly pelagic medusoids which differ from the class Hydrozoa in possessing endodermal gastric tentacles, four-part radial symmetry, and gonads located in the gastric cavity. The polyp stage is reduced or absent.

scyphus Cup-shaped or funnel-shaped structure, e.g. the cup-shaped podetia of some species of *Cladonia*.

Scytalopus (tapaculo; family Rhinocryptidae) Genus of small, dark, grey-black tapaculos which have some barring underneath, particularly the immatures. They have short tails, and some have white supercilia or under-parts. They inhabit dense, humid forest in C. and S. America. There are 12 species.

Scytonema (order Nostocales) Genus of filamentous cyanobacteria, in which the filaments show 'false branching' due to a loop of trichome breaking through the sheath and then rupturing. The filaments have distinct basal and apical regions and form erect tufts, on wet rocks, soil, etc.

Scytodidae (spitting spiders; order Araneae, suborder Araneomorphae) Family of spiders whose common name refers to their unique mechanism for capturing prey. The high, domed carapace bears six eyes in three groups, and accommodates the large salivary and poison glands. Some species occupy a web and others are nocturnal, but all spit at their

prey or enemies. The prosoma is lifted up and threads of sticky substance and poison are sprayed from the chelicerae in a zigzag fashion, pinning the prey to the substrate. *Scytodes thoracica* is an inhabitant of buildings in northern latitudes, and other species are tropical.

Scytosiphonaceae (order Ectocarpales) Family of algae in which the thallus is parenchymatous and growth is mostly diffuse. *Scytosiphon lomentaria* is a common British species, consisting of loosely tufted, tubular fronds. *Petalonia* has flat, leaf-like fronds and is found mainly on rocks on the lower shore. *Colpomenia* has a thallus consisting of thin-walled hollow spheres. *See also* oyster thief.

sea 1 Large body of usually saline water which is smaller in size than an ocean. 2 Chaotic waves generated by the action of the wind on the surface layers of the ocean. *See also* ocean wave; and swell.

sea anemone *See* Actiniaria; Anthozoa; Ceriantharia; Cnidaria; and Zoanthiniaria.

sea bass *See* Serranidae.

sea-belt (sugar kelp) Common name for the brown seaweed *Laminaria saccharina*. The thallus consists of a branched, root-like holdfast, a smooth, slender stipe, and a yellowish-olive frond which is single and ribbon-like with an undulating central region and frilly margins. When dry, a whitish, sweet-tasting deposit sometimes appears on the surface of the fronds, hence the alternative name 'sugar kelp'. Another alternative name is 'poor man's weather glass' since under humid conditions the fronds remain soft and limp, whereas under dry conditions they become hard and brittle.

sea bream *See* Sparidae.

sea breeze *See* land and sea breezes.

sea carps *See* Aplodactylidae.

sea chub *See* Kyphosidae.

sea cow *See* Dugongidae; and Sirenia.

sea cucumbers *See* Holothuroidea.

sea fan *See* Gorgonacea.

sea-floor spreading Theory advanced in the early 1960s, proposing that the floors of certain oceans (e.g. the Atlantic) are growing larger and the continents bordering them are consequently moving further apart. Later, the theory became incorporated within the more unifying theory of plate tectonics.

sea fret Popular local term for sea fog, common in spring and summer in Cornwall and on the south, east, and north-east coasts of England.

sea hares *See* Anaspidea.

sea heaths *See* Frankeniaceae.

sea holly *See Eryngium*.

sea horse (*Hippocampus hippocampus*) *See* Syngnathidae.

sea ice In polar regions the surface of the sea freezes, due to the low air and water temperatures: the product is known as 'sea ice'. It exists year-round in the central arctic and in some antarctic bays, extending in winter across the entire arctic and far out to sea around Antarctica. As ice crystals form from sea-water so salt is excluded and eventually returned to the sea. Sea ice therefore contains no salt.

seal *See* Phocidae.

sea lamprey (*Petromyzon marinus*) *See* Petromyzonidae.

sea lettuce Common name for the green, sheet-like seaweed *Ulva lactuca*.

sea lilies *See* Articulata; Bourgueticrinida; Crinoidea; Isocrinida; Millericrinida; Millericrinina; and Roveacrinida.

sealing-wax palm (*Cyrtostachys lakka*) *See Cyrtostachys*.

sea lion *See* Otariidae.

sea mice *See* Errantia.

sea moth *See* Pegasidae.

seamount Isolated, submarine mountain rising more than 1000 m above the ocean floor. The sharp, crested summits of seamounts are usually 1000–2000 m below the ocean surface. Seamounts are of volcanic origin. *See also* guyot.

sea oak Common name for the brown seaweed *Halidrys siliquosa* (family Cystoseiraceae), a perennial species with regular, alternate branching, and a characteristic zigzag axis. Stalked air bladders resembling seed pods are present; these may be up to 5 cm long and are divided internally by septa into 10 or 12 compartments. They are common and widely distributed at or below low-water mark, or in deep rock pools on sheltered coasts.

sea pen *See* Anthozoa; Pennatulacea; Sessiliflorae; and Subselliflorae.

searcher *See* Bathymasteridae.

searching Behaviour by an animal that is directed toward the provision of some necessity (e.g. food, nesting material, or a mate) that has not yet been located.

searching image Mental image of an object apparently possessed by an animal searching for that object, whose existence is inferred from observation of the behaviour of animals.

Searsiidae (tubeshoulder; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of deep-sea fish, which have a single, soft-rayed, dorsal fin near the tail-fin, above the anal fin. The eyes and mouth are rather large. The peculiar shoulder organ is typical of the family. It is a large, black sac opening to the exterior through a tube-like process above the pectoral fin. When the sac contents are released, a greenish glow appears beside the fish. Many species, e.g. *Sagamichthys abei* (33 cm) have a widespread distribution. There are about 17 species.

sea sawdust *See Trichodesmium*.

sea slaters *See* Ligiidae.

sea slugs *See* Opisthobranchia.

seasnail *See* Cyclopteridae.

sea snakes *See* Hydrophiidae.

sea squirts *See* Urochordata.

sea thong Common name for the brown seaweed *Himanthalia elongata* (Himanthaliaceae), found in deep rock pools or at the low-water mark.

sea urchins *See* Echinoidea.

seaweed Common name for a macroscopic marine alga. Seaweeds belong to the classes Phaeophyceae (brown seaweeds), Rhodophyceae (red seaweeds), and Chlorophyceae (green seaweeds).

seaweed flies *See* Coelopidae.

sebaceous gland In Mammalia, a skin gland projecting deep into the dermis and almost always opening into a hair follicle, which secretes a fatty substance which helps to waterproof the hair.

Sebastes marinus (ocean perch) *See* Scorpaenidae.

Secchi disc Disc used in a simple method for measuring the transparency of water. The disc is 20 cm across, and divided into alternate black and white quadrants. It is lowered into water on a line until the difference between the black and white areas just ceases to be visible—this depth is recorded. The Secchi disc provides a convenient method for comparing the transparencies of water at different sites.

secondary depressions Depressions initiated as part of a 'family' or sequence of wave disturbances along a cold front; they are in the rear of the first depression of the series. *See also* frontal wave.

secondary front Frontal development in the colder air in the rear of a depression, in the form of a further trough of low pressure following the main cold front.

secondary genitalia *See* accessory genitalia.

secondary productivity *See* primary productivity.

secondary sexual character Characteristic of animals that differs between the two sexes, but excluding the gonads and the ducts and associated glands that convey the gametes. Examples are mammary glands, external genitalia, antlers in ungulates, and certain plumage patterns (e.g. peacock's tail) in birds.

secondary structure The folding of a polypeptide or polynucleotide chain along one axis of the molecule; it is stabilized by the formation of intramolecular hydrogen bonds along the length of the chain.

secondary succession Succession initiated by the disruption of a previously existing seral or climax community by some major environmental disturbance and leading to a marked change in the stable vegetation community. Secondary successions occur, for example, following fire, after removal of grazing pressure, or when previously cultivated areas are abandoned (as in shifting cultivation). Interactions between plants and the physical environment tend to be less clear in secondary than in primary successions.

secondary thickening The formation of new tissue by the repeated lateral division of cells in the cambium of a woody plant, adding successive layers of new growth. This increases the girth of the stem or root and the growth can be seen as annual rings. Much of the woody part of a woody plant is the result of secondary thickening.

secondary woodland Woodland occupying a site that has not been wooded continuously throughout history (in Britain since the last ice advance). It may be the product of natural succession or of planting on formerly unwooded land.

secondary-woodland species Tree species that are frequent and often abundant in secondary woodland. Usually they are good colonizers, or are abundant in many habitats, or both.

secretary bird (*Sagittarius serpentarius*) *See* Falconiformes; and Sagittariidae.

secretion 1 The act of discharging materials from cells. 2 Any material discharged from cells.

sectility *See* argentite.

secund Arranged on one side, or curved to one side.

Securinega (family Euphorbiaceae) Genus of small trees which produce very hard wood. There are 25 species, occurring in temperate and tropical regions.

Sedentaria (bamboo worms, coneworms, fanworms, lugworms; phylum Annelida, class Polychaeta) Subclass of entirely marine, polychaete worms, in which the body segments and parapodia differ along the length of an individual. All Sedentaria are burrowers or tube-dwellers. They are first recorded from the Ordovician.

sedges *See Carex*; and *Cladium*.

sedimentary rock Rock formed by the deposition and compression of mineral and rock particles, but often including material of organic origin and exposed by various agencies of denudation. Sedimentary rocks may be classified as clastic, organic, or chemical. They may also be described according to their chemical properties and behaviour and environmental deposition, and each scheme complements the others.

sedimentation coefficient Measure of the rate of sedimentation of a molecule or particle: it is equal to the velocity per unit centrifugal field (acceleration), and is measured in Svedberg units.

Sedum (stonecrops) *See* Crassulaceae.

seed In the sexual reproduction of spermatophytes (seed plants), the discrete body from which a new plant develops. Formed from a fertilized ovule, the seed comprises an outer coat (testa), containing a food store and an embryo plant. The food may be stored in the seed leaves (cotyledons) of the embryo itself, or around the embryo in the endosperm.

seedeaters *See Serinus*.

seed shrimps *See* Ostracoda.

seedsnipe *See* Thinocoridae.

seed weevil *See* Bruchidae.

segmentation *See* cleavage.

segregation, Mendel's law of *See* Mendel's laws.

seiche Stationary or standing wave characterized by an absence of progressive forward motion; instead the water surface moves up and down as the wave moves backwards and forwards. Seiches are most common in enclosed or semi-enclosed water bodies, e.g. bays and lakes. The waves are usually the product of intense storm activity.

seif dune Relatively short, linear dune consisting of curved, sword-like components, and found in hot deserts. Typically it is developed by the elongation of a barchan arm, and built up by winds blowing from two principal directions. *See also* dune.

seismology The study of all phenomena associated with earthquakes, especially the shock (seismic) waves they produce. Seismologists elucidate the deep structure of the Earth.

seismonasty Nastic movement in plants in response to a sudden stimulation by touch.

Seisonoida (phylum Aschelminthes, class Rotifera) Order of entirely marine, free-swimming, aschelminth worms in which the reproductive organs are paired. Males and females are morphologically identical.

Seistan wind Regional wind from the north of Seistan, E. Iran, which blows with great force and constancy in summer for a period of months.

sei whale (*Balaenoptera borealis*) *See* Balaenopteridae.

Selachimorpha Superorder of cartilaginous fish including all sharks.

Selaginellaceae Family of the Pteridophyta in the wide sense, or of the Lycopsida in the narrower sense, of plants similar to the clubmosses (Lycopodiaceae), but showing heterospory, with megasporangia, each containing usually only four large megaspores (which germinate into female gametophytes), and microsporangia, each containing many tiny microspores (which germinate into male gametophytes). The plants have tiny leaves, like the true clubmosses, but these may be either spirally arranged and all of similar form, or in four ranks along the stems, two ranks of leaves being much larger than the others. All *Selaginella* leaves have a tiny, tongue-like structure, the ligule, on the upper surface near the base. All the species have their sporangia in cones. Probable relatives of the living Selaginellaceae were very important components of the Upper Carboniferous coal-measure forests (Lepidodendrales), and many were large trees. There is one genus, with some 700 species, of worldwide range.

selangan batu *See Shorea*.

selection Process that determines the relative share of different genotypes which individuals possess and propagate in a population. The relative probability of survival and reproduction of a genotype is termed the 'fitness' or 'Darwinian fitness'.

selection coefficient (*s*) A measure of the relative excess or deficiency of fitness of a genotype compared with another genotype in the population. If $s = 100$ then one out of a hundred individuals of a given genotype fails to reproduce.

selection differential The difference between the average value of a quantitative character in the whole population and the average value of those selected to reproduce the next generation.

selection pressure Pressure exerted by the environment, through natural selection, on evolution. Thus weak selection pressures result in little evolutionary change and vice versa.

selective species In phytosociology, a plant species found most frequently in a particular community, but also present occasionally in others. It is fidelity class 4 of the Braun-Blanquet scheme. *Compare* accidental species; exclusive species; indifferent species; and preferential species.

selective value *See* adaptive value.

selenite *See* gypsum.

selenodont Applied to molar teeth in which the grinding surfaces possess crescent-shaped ridges.

Seleviniidae (dzhalmans; order Rodentia, suborder Myomorpha) Family of small, burrowing, mainly insectivorous rodents, which have somewhat rounded heads, large ears, and long, sparsely haired tails. They resemble dormice in many respects, but the hind legs are longer than the forelimbs and they move by leaping. The tympanic bulla is very large and the angular process of the jaw is perforated. The upper incisors are large, the cheek teeth very small, with large central basins, and rooted. Dzhalmans are found only in the Betpakdala Desert of C. Asia. There is one genus, *Selevinia*, and one species.

self-fertilization The fusion of male and female gametes from the same individual (as opposed to cross-fertilization, in which the gametes come from different individuals).

selfheals *See Prunella*.

selfish DNA One of a number of hypotheses advanced in an attempt to explain the presence of surplus DNA in the genome which is not translated into protein. Three hypotheses have been put forward to account for the adaptive advantage of this apparently redundant DNA: (a) that extra DNA separates the genes so as to increase the cross-over frequency; (b) that the possibility of varying the total amount of DNA per cell allows the control of cell volume and cell growth rate; and (c) (the selfish DNA hypothesis) that selection acts within the genome favouring any method by which DNA may more rapidly replicate itself, and that this can be better achieved if phenotypic expression can be bypassed. This is achieved, it is proposed, by DNA spreading laterally so as to be duplicated at new loci elsewhere in the genome. In this way the DNA may be viewed as acting 'selfishly', since the apparently surplus DNA confers no advantage on the organism bearing it and therefore supplying the materials from which it is made. *See also* selfish genes.

selfish genes Epithet used by some authors to reinforce their notion that organisms function as agents for replication of genes, as opposed to genes functioning as servants of organisms. *See also* selfish DNA.

self-mulching soil A soil that mixes itself: its surface layers shrink and swell, forming deep cracks into which soil falls.

self-pollination The transfer of pollen from anther to stigma of the same plant (either of the same flower or of a different flower, but always of the same individual).

selva Tropical rain forest. The term is applied specifically to the Amazon Basin, and is often used to denote similar vegetation in other areas.

Semaeostomatida (subclass Scyphomedusae) Order of free medusae, typically flat or saucer-like in shape; the angles of the square-shaped mouth are drawn out into long, frilly lobes. They are found in great numbers in coastal waters of all oceans, in all latitudes.

Semecarpus (family Anacardiaceae) Genus of trees and treelets in which the leaves are simple, and often crowded. It is a rengas genus, producing an irritant black sap. Some species have attractive timber. There are 50 species, occurring in lowland tropical rain forest from Indo-Malaysia to the Solomon Islands.

semicircular canal In Gnathostomata, one of the three fluid-filled cavities, semicircular in shape, arranged at right angles to one another, and located within the inner ear. They register movement of the head and are associated with balance.

semi-desert scrub Distinct tropical formation type situated geographically between thorn forest and desert. The vegetation is sparser than that of the thorn forest and succulents are more common, as a consequence of the drier climate. Most of the plants are shallow-rooted, and so able to exploit before it evaporates any precipitation that percolates into the surface layer of the soil.

semi-evergreen seasonal tropical forest Distinct formation type, dominated by both evergreen and deciduous broad-leaved trees, flanking the rain forest in areas which have a marked dry season. Examples are found on all the continents with tropical territory, but are especially extensive in C. and S. America, SE Asia, and N. Australia. In Africa, savannah and related types of vegetation seem to have replaced much of this kind of forest.

semi-natural community Vegetation, altered by human influence or management in the past, which has taken on a natural aspect due to the length of time over which the influences have persisted. For example, heathland and chalk grassland in Great Britain have long been subject to management and members of each community have adapted to it. In chalk grassland many plant species are low-growing rosette plants which avoid being grazed. *Compare* near-natural community.

semi-natural woodland On an ancient woodland site, stands of mainly native trees that have not been obviously planted, whose presence appears to be natural, and that have been managed over a period, resulting in some change in woodland structure and species composition. On a recent woodland site, the term includes all stands that have originated mainly by natural regeneration.

Semionotiformes Order of bony fish, including fossil and living representatives, the latter usually placed in the family Lepisosteidae.

semipalmate In birds, applied to feet that have partially webbed toes, the webs not reaching to the ends of the toes.

semipermeable Applied to a barrier, usually a membrane, whose structure allows the passage of small molecules but prevents the passage of larger ones.

semi-species Group of organisms that are taxonomically intermediate between a race and a species, with reduced outbreeding and gene flow, i.e. with incomplete reproductive isolating mechanisms. Semi-species are thought to represent advanced stages of speciation.

Sempervivum (house leeks) *See* Crassulaceae.

sempilor *See Dacrydium elatum*.

sena Timber from *Pterocarpus indica*. *See Pterocarpus*.

Sendai virus (para-influenza virus I) Strain of paramyxovirus; it appears not to cause disease in humans.

Senecio (family Compositae, subfamily Asteroideae, tribe Senecioneae) Genus of annual and perennial herbs, shrubs, and trees, many of which are succulent. The leaves are spirally arranged and alternate, without stipules. The flower heads are solitary or in corymbs, and are heterogamous. The involucral bracts are in one row, sometimes with a few, outer, short bracts. The ray florets are flattened and female, or absent, the disc florets tubular and bisexual. The achene is ribbed and cylindrical, usually with a simple pappus. Most species are xerophytic, with either fleshy leaves and stems, or hairy with inrolled leaves. Several tree species are found at very high altitudes on E. African volcanoes. Several species are ornamentals. Many are now widespread and noxious weeds, e.g. *S. jacobaea* (the British common ragwort). There are more than 2000 species, with a cosmopolitan distribution, mainly centred in S. Africa, the Mediterranean, Asia, and America.

Senecio jacobaea (the British common ragwort) *See Senecio*.

senescence The complex deteriorative processes that terminate naturally the functional life of an organ or organism. In plants this may be associated with flowering and fruiting and an important contributing factor is the decrease in chlorophyll content and in the ability of the plant to photosynthesize. Plant senescence is controlled by hormones.

Senftenbergia sturi One of the earliest species referred to the extant fern family, the Schizaeaceae.

Fertile leaf fragments have been described from the Lower Carboniferous of Scotland.

senna *See Cassia*.

sensilla ampullacea *See* Solifugae.

sensitive period Period of time during which a young animal is most impressionable and therefore most likely to acquire learned behaviour. This is the period during which imprinting occurs.

sensitive plant (*Mimosa pudica*) *See Mimosa*.

sensitivity analysis the consideration of a number of factors involved in the mathematical modelling of an ecosystem and its components. These include feedback and control, and the stability and sensitivity of the system as a whole to changes in some parts of the system. From the analysis, predictions can be made.

sensitization The increase in the likelihood that a particular and significant stimulus will produce a response in an animal repeatedly exposed to it. *Compare* extinction; and habituation.

sentry palm *See Howea*.

sepal In a flower, one of the outer floral leaves, usually greenish, which are borne in a tight spiral or whorled.

sepaloid Sepal-like.

sepetir *See Sindora*.

Sepioidea (cuttlefish; class Cephalopoda, subclass Coleoidea) Order of cephalopods which have an internal phragmacone, which may be curved or coiled. They possess eight arms and two tentacles. They probably diverged from a belemnoid ancestor in the early part of the Cretaceous Period.

Sepsidae (ensign flies; class Insecta, order Diptera, suborder Cyclorrapha) Small family of flies in which the adults are small and often ant-like. The head may or may not have vibrissae, and the palps are reduced. The costa is unbroken, vein Sc is complete, and vein R_1 is bare above. In males the front femora usually have stout spines or bristles. The most characteristic feature of adult males is their habit of collecting on vegetation, where they walk about waving their wings, which accentuates the usual black, spotted wing-tips. These aggregations may be sexual in function. The larvae are saprophagous, and have been collected from dung. Adults feed on flowers. There are about 200 species, found throughout the world. *See also* venation.

septa *See* septum.

septate Having cross-walls or septa.

septate junction Type of adhesive cell junction, particularly characteristic of invertebrate tissues, in which the membranes forming the junction are held very regularly 15–17 nm apart. Traversing this gap at right angles to the cell surface there are crossbars of dense material, the septa. In sections taken parallel to the cell surface, these septa are revealed as pleated sheets that zigzag between the opposed membranes in parallel rows.

septicaemia Condition in which large numbers of bacteria (or occasionally fungi) and their toxic products are present in the blood.

septicaemic plague *See* plague.

Septoria (order Sphaeropsidales) Form-genus of fungi which produce elongated, thread-like, septate conidia. There are many species, some of which are important plant pathogens which can infect cereals, celery, tomatoes, etc.

septum (pl. septa) Cross-wall or partition. *See also* septate junction.

sequester To bind a metal ion into a chelate.

Sequoia (family Taxodiaceae) Genus of evergreen conifers, comprising one species, *S. sempervirens* (coast redwood) of the N. American coastal fog belt from Oregon to California. *Sequoia* species are giant, columnar trees, probably the tallest in the world. Their bark is soft and spongy, and they yield valuable timber. The leaves are spreading and yew-like.

Sequoiadendron (family Taxodiaceae) Genus of evergreen conifers, comprising one species, *S. giganteum* (big tree, or 'Wellingtonia'), native to the Pacific slopes of the Sierra Nevada in California. These are giant trees, with soft, spongy bark. The leaves are short and clasp the twig.

sera *See* serum.

serac Ice pinnacle found on the surface of a glacier and resulting from tensional failure in the more rigid upper crust. This is due to the stretching that occurs when a glacier moves over a convex-up slope, spreads out over a plain, or passes round a bend in its valley.

seral stage Phase in the sequential development of a climax community. *See* succession.

sere The characteristic sequence of developmental stages occurring in plant succession. *See* competition; ecesis; migration; nudation; reaction; stabilization; and succession.

serein The fall of rain from an apparently clear sky. The phenomenon may be explained by the evaporation of cloud particles following the formation of rain droplets, or by the movement of cloud away from the overhead position as the rain approaches the ground.

Sergeant Baker (*Aulopus purpurissatus*) *See* Aulopodidae.

Serianthes (family Leguminosae, subfamily Mimosoideae) Genus of trees which have big, pinnate leaves, and numerous small leaflets. The pod is flat, and indehiscent. Several species grow fast. There are 10 species, occurring from E. Malesia to the Pacific islands.

seriemas *See* Cariamidae.

series (geol.) The chronostratigraphical equivalent of an epoch. It denotes the layers of strata or the body of rock formed during the one epoch.

Seriola dumerili (amberjack) *See* Carangidae.

Seriolella brama (warehou) *See* Centrolophidae.

serine Aliphatic, polar alpha-amino acid. It is often associated with the active site of an enzyme.

Serinus (canaries, seedeaters; family Fringillidae) Genus of small to medium-sized finches, with mainly yellow, green, brown, and grey streaked plumage. They have small to fairly large conical bills. They are good singers and many are kept in captivity. *S. canaria* (canary) is bred in a variety of colour forms and plumage variations. *Serinus* species inhabit forests, open woodland, and cultivated land; they feed on seeds, and nest in trees. There are about 32 species, found in Europe, Africa, and Asia.

Serinus canaria (canary) *See Serinus*.

serir Veneer of mixed sand and gravel mantling a Saharan plain and transported originally by sheet-wash and braided-stream activity. Subsequently it was weathered and modified under more arid conditions.

serotinal In late summer. The term is used with reference to the six-part division of the year used by ecologists, especially in relation to studies of terrestrial or freshwater communities. *Compare* aestival; autumnal; hibernal; prevernal; and vernal.

serotonin 5-hydroxytryptamine, a derivative of tryptophan. This is a powerful vasoconstrictor found especially in the brain, intestinal fluid, mast cells, and blood platelets, and also in snake and toad venoms. Curiously it has also been found in nettles, bananas, and tomatoes. In humans it has been suggested as a cause of migraines.

Serpentes (Ophidia, snakes; order Squamata) Suborder of elongate, limbless reptiles which evolved from burrowing lizards in the Cretaceous. They are carnivores, in which the jaws are held by ligaments and are capable of considerable extension. There are no eyelids; the eyes are covered by a spectacle (transparent scale). The skin is usually shed whole. There is no tail regeneration. The tongue is generally forked and protruded through a notch in the snout. There are 12 families.

serpentine Secondary mineral, specific gravity 2.5–2.6, hardness 2.5–4.0, chemical composition $Mg_3Si_2O_5(OH)_4$, formed from olivine and orthopyroxene. It is distinguished by its colour, lustre, and greasy feel. It can be various shades of green, and also brown, grey-white, or yellow. It has a greasy to waxy lustre which is occasionally silky. It crystallizes in the monoclinic system. The crystals often occur as fibres, or as long, platy lamellae. Serpentine is used extensively as a facing stone and for ornament.

serpentine barrens Impoverished, often scrubby or heathy vegetation associated with serpentine rocks. On weathering these rocks release an excess of magnesium into the soil, and this often inhibits the development of the natural climax in the areas concerned.

serpentinite Altered rock formed from an ultrabasic precursor by low temperature and water interaction. Such rocks are compact, variously coloured, and may have considerable ornamental value. They consist mainly of hydroxyl-bearing magnesium silicates formed from original olivine and pyroxenes.

Serpula (family Coniophoraceae) Genus of fungi which includes the dry-rot fungus *S. lacrymans* (formerly *Merulius lacrymans*), a serious agent of timber decay in buildings. The fungus can spread from one timber to another across brickwork and through mortar. Rust-red spores are produced in shallow pores which form a honeycomb-like layer. Dry rot is rare outside buildings.

Serranidae (sea bass, grouper; class Osteichthyes, subclass Actinopterygii, order Perciformes) Very large family of marine fish, often with a somewhat robust, fully scaled body, the single, continuous, dorsal fin consisting of a spiny and a soft-rayed section. The mouth is often large; the lateral line is continuous from head to tail. Many species are hemaphroditic, the individual fish changing sex during its lifetime. Serranidae range in size from the relatively small *Serranus cabrilla* (comber), 35 cm, of the Atlantic, to *Promicrops lanceolatus* (Queensland grouper), 3.6 m, found in the Indo-Australian region. There are at least 370 species, found in temperate to tropical seas.

Serranus cabrilla (comber) *See* Serranidae.

Serrasalmus rhombeus (white piranha) *See* Characidae.

serrated wrack (toothed wrack) Common name for the brown seaweed *Fucus serratus*. The thallus is flattened and branched, and the edges are serrated with forward-pointing teeth. The wrack is found near low-water mark and is very common. Small white coiled tubes of the worm *Spirorbis* are commonly found on the surface of the thallus.

Serrivomeridae (class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of deep-sea eels, which have distinctly produced, beak-like jaws; a scaleless body; minute pectoral fins; and the dorsal fin originating behind the anal fin. Many species, e.g. *Serrivomer jesperseni* (crossthroat sawplate), 41 cm, have a worldwide distribution and may be found at depths exceeding 800 m. There are about 10 species.

Serrivomer jesperseni (crossthroat sawplate) *See* Serrivomeridae.

serum (pl. sera) The clear fluid that remains after blood is allowed to clot. It differs from plasma in that it lacks fibrinogen.

sesame *See* Pedaliaceae.

Sesamum indicum (sesame) *See* Pedaliaceae.

Sesiidae (Aegeriidae, clearwings; order Lepidoptera) Family of fairly small moths which mimic bees and wasps both in colour and shape, and sometimes buzz in a similar way. Scales are absent from large areas of the wings. The thorax and abdomen usually bear wasp- or bee-like colours. Sesiidae fly rapidly and by day. Larvae often tunnel in stems of trees and shrubs. Some are pests of fruit trees. They are distributed worldwide.

sesquioxides General term for the hydrated oxides and hydroxides of iron and aluminium.

sessile 1 Lacking a stalk. 2 Attached to a substrate; non-motile.

Sessiliflorae (order Pennatulacea) Suborder of recent sea-pens with a doubtful fossil record from the Silurian, Jurassic, and Cretaceous. Polyps arise from the rachis separately and are not united near their bases. The suborder contains 11 families, with 22 genera.

Sessilina (order Peritrichida) Suborder of ciliate protozoa in which the adult cells may be stalked and are attached to submerged objects in still or slow-moving freshwater habitats. There are six families, with many genera.

seta 1 Stiff hair-like or bristle-like structure. 2 The stalk of a moss or liverwort capsule.

setation *See* chaetotaxy.

setose Bearing bristles or setae.

sevengill shark (*Notorynchus maculatus*) *See* Hexanchidae.

seven-spot ladybird (*Coccinella septempunctata*) *See* Coccinellidae.

severalty (inseveralty) Land that is held as private property and is enclosed, as opposed to common land.

sewage fungus Slimy growth found in sewage and sewage-polluted waters. It consists mainly of filamentous bacteria.

sex chromatin *See* Barr body.

sex chromosome Chromosome whose presence or absence is linked with the sex of the bearer, and plays a role in sex determination. It is present in all sexually reproducing diploid animals and plants. The sex that has a homologous pair of sex chromosomes in the nucleus is said to be homogametic (referred to as 'XX'), whereas the sex with a dissimilar pair or with an unpaired chromosome, is said to be heterogametic (referred to as 'X' or 'XY'). The homogametic sex produces gametes that are identical in their chromosome sets, all containing one X-chromosome. The heterogametic sex produces equal numbers of two different types of gametes, one with one X-chromosome, and one without (possessing either a Y-chromosome or none at all). Union of gametes of the two sexes thus results in equal numbers of offspring of the two sexes. In mammals and many other animals the presence or absence of a Y-chromosome determines sex; in birds and reptiles, and in some fish, amphibians, and insects, sex is determined by the number of X-chromosomes in relation to the number of autosomes. Occasionally a mutation will produce an extra dosage of X-chromosomes in the gamete, and so in the progeny—in Klinefelter's syndrome in humans, for example, the individual genotype (a male) possesses an extra X-chromosome (XXY).

sex determination The mechanism by which sex is determined. In many species, sex is determined at fertilization by the nature of the sperm that fertilizes the egg, Y-bearing sperm producing the male zygotes, and X-bearing sperm, female zygotes. *See also* sex chromosome.

sex linkage The location of a gene on a sex chromosome. Such a gene is usually unrelated to primary or secondary sexual characters, and is located on the X-chromosome. The heterogametic sex (e.g. a male mammal or female bird) receives the X-chromosome and therefore all its sex-linked genes from the homogametic parent, and passes them on to offspring of the homogametic sex. Since there is no partner to the X-chromosome in the heterogametic sex, recessive genes cannot be masked by their dominant alleles and so are expressed in the phenotype. It is for this reason that male humans manifest a larger number of recessive genes (e.g. red–green colour blindness, and haemophilia) than females.

sex ratio The relative number of males to females in a population. The measure is usually applied to a given age class. The primary sex ratio is that immediately after fertilization (normally 1 : 1); the secondary sex ratio is that at birth or hatching; and the tertiary sex ratio is that at maturity.

sex reversal Change in functioning as one sex to that of the other. Some organisms, e.g. certain molluscs, make this change as part of their normal life cycle, with most individuals functioning as males when young and then passing through a transitional stage to a period when they function as females. Sex reversal may otherwise be experimentally induced (e.g. by hormone transplants in humans) or environmentally induced (e.g. by temperature effects on the production of male or female zygotes in some turtles).

sexton beetle *See* Silphidae.

sexual dimorphism Phenomenon of morphological differences (besides primary sexual characters) that distinguish males from females of a species of organism—for example, male deer often have larger antlers than females, and the males of many birds have differing plumage (often more brightly coloured).

sexual generation In cynipid, heterogynous wasps, the males and females that emerge from galls to mate and lay eggs that will become the agamic generation of parthenogenetically reproducing females. In general, sexual-stage galls follow a period of rich resources and precede a period of poor resources. Sexual individuals are generally smaller and less fecund than members of the agamic (asexual) generation.

sexual isolation *See* ethological isolation.

sexual reproduction Reproduction involving the fusion of haploid nuclei, usually gametes, which result from meiosis.

sexual selection Theory proposed by Darwin that in some species males compete for mates and that characteristics enhancing their success in mating would have value and be perpetuated irrespective of their overall value in the struggle for existence. Such characters would be used either in male display to attract females (inter-sexual selection) or in combat between rival males (intra-sexual selection), and both could act at the same time.

Seychelles giant tortoise *See Testudo gigantea*.

Seymouria One of the more problematic of fossil amphibians, possessing a combination of amphibian and reptilian characters and having been referred to both groups on different occasions. One of the features separating it and its relatives from other amphibians is the presence of a large, forward-extended optic notch (the primitive site of the ear drum). A medium-sized amphibian, it existed during the Lower Permian in N. America.

shade temperature The temperature of the air, conventionally measured in a standard shelter or screen that protects the thermometer from rain and from direct sunshine, but that allows the free passage of air.

shaggy cap (shaggy ink cap) Common name for the fruit body of *Coprinus comatus*. The cap is initially white, with white or brownish scales, and initially oval, later becoming bell-shaped. It undergoes autodigestion, dissolving from the edges into an inky-black fluid. The stipe bears a membranaceous, movable ring. It is common in fields, on grass banks, etc., often growing in clusters. It is edible when young.

shags *See* Phalacrocoracidae; and *Phalacrocorax*.

shake-hole Local term descriptive of a funnel-shaped doline, about 3 m deep and 8–11 m in diameter, found in NW Yorkshire, England. It is developed where limestone is overlain by shale or by superficial material such as glacial drift, and is formed by the collapse of this overlying material into a cavity developed by solution.

shale 1 Fine-grained, fissile, sedimentary rock composed of clay-sized and silt-sized particles of unspecified mineral composition. 2 (oil shale) Dark grey or black shale containing organic substances that yield liquid hydrocarbons on distillation, but that do not contain free oil.

shamal Regional north-westerly wind which brings hot, dry conditions in summer to Iraq and the Persian Gulf. It blows with great force during the day.

Shannon–Wiener index of diversity (information index) Measure used by ecologists when a system contains too many individuals for each to be identified and examined. A small sample is used; the index is the ratio of the number of species to their importance values (e.g. biomass or productivity) within a trophic level or community.

sharka disease *See* plum pox.

shark-toothed whales *See* Squalodontoidea.

sharpbill (*Oxyruncus cristatus*) *See* Oxyruncidae.

shatter cone Striated, conical fragment of rock along which fracturing has occurred. Shatter cones generally occur in groups or assemblages and are believed to originate from the shock waves imparted to rocks following a meteorite impact.

shea butter *See Butyrospermum*.

shear vector *See* wind shear.

shearwaters *See* Procellariidae; Procellariiformes; and *Puffinus*.

sheath 1 Of leaves, the base of a blade or stalk that encloses the stem. 2 (of cyanobacteria) *See* capsule (of prokaryotes).

sheathbills *See* Chionididae.

sheep (*Ovis*) *See* Bovidae.

sheep pox Disease which, under natural conditions, affects only sheep. Symptoms involve fever and the development of pocks. Mortality rate varies from low to high. The disease is economically important and is a notifiable disease in Britain. The causal agent is a poxvirus.

sheet lightning The appearance of lightning flashes when cloud cover causes the diffusion of their light.

sheet-web spiders *See* Agelenidae.

shelducks *See Tadorna*.

shelf fungus Common name for any fungus with a shelf-like fruit body that juts out horizontally from its substrate, usually a tree or log.

Shelford's law of tolerance Law that states that the abundance or distribution of an organism can be controlled by certain factors—such as the climatic, topographic, and biological requirements of plants and animals—where levels of these exceed the maximum or minimum levels of tolerance of that organism.

shell beak In Bivalvia, the oldest part of the shell, located near the hinge.

shelled pteropods *See* Thecosomata.

shell gland 1 In Branchiopoda, an excretory organ in which the duct is visible through the wall of the carapace. 2 In some Platyhelminthes, a gland that secretes a substance that causes the hardening of egg shells.

shelly limestone Carbonate rock that contains a large proportion of shell or shell fragments.

shepherd's purse (*Capsella bursa-pastoris*) *See Albugo*.

shield-backed grasshoppers *See* Tettigoniidae.

shieldbug *See* Pentatomidae.

shield-tailed snakes *See* Uropeltidae.

shifting cultivation (slash-and-burn agriculture) The traditional agricultural system of semi-nomadic people, in which a small area of forest is cleared by burning, cultivated for 1–5 years, and then abandoned as soil fertility and crop yields fall and weeds encroach. Ideally vegetation succession subsequently returns the plot to climax woodland, and soil fertility is gradually restored. Shifting cultivation of this type was once practised worldwide but in modern times has been primarily associated with tropical rainforest areas. The system is best-suited to low population densities. With increasing population pressure abandoned plots are often cleared again before a full climax community has been restored, leading eventually to nutrient depletion of the system and degradation of forest to open savannah-type woodland, or scrub.

Shigella (family Enterobacteriaceae) Genus of Gram-negative, rod-shaped, non-motile bacteria.

There are four species, found in the intestines of humans and higher monkeys. They are the causal agents of dysentery.

shii-take Fungus (*Lentinus edodes*) cultivated for food, e.g. in Japan.

shimmer (atmospheric boil) The continuously varying distortion of objects at low levels due to variations in surface atmospheric properties, as over strongly heated ground.

shingle Beach pebbles, normally well rounded as a result of abrasion, whose diameters are typically 0.75–7.5 cm. They are made of resistant materials such as flint, which is the dominant constituent of the shingle beaches of SE England. It may also show lateral sorting, e.g. the shingle of the Chesil Beach, Dorset, England, steadily increases in size over 29 km from west to east.

shingles Acute human disease in which a localized rash develops on the skin in a region served by a particular nerve. It is caused by a herpesvirus, and may be due to the activation of a latent virus infection remaining from an earlier attack of chickenpox.

shoal See school.

shoal retreat massif Large sand accumulation preserved on the continental shelf during and after a marine transgression. The massifs represent former estuary-mouth sand bars (inlet-associated shoals) or former zones of longshore-drift convergence (cape-associated shoals). In the Middle Atlantic Bight of the east coast of the USA the massifs are up to 72 km long by 21 km wide and can be found offshore from the present Hudson, Delaware, and Chesapeake estuaries, and longshore-drift convergence zones such as Cape Hatteras.

shoe-bill (*Balaeniceps rex*) *See* Balaenicipitridae.

shola (*Aeschynomene aspersa*) *See Aeschynomene*.

shoot frequency *See* root frequency.

shooting star *See* meteor.

Shorea (balau (Malaya), lauan (Philippines), selangan batu (Borneo), red meranti, white meranti; family Dipterocarpaceae) Genus of trees, many of which are huge, whose fruits have three enlarged, wing-like sepals. Many species yield valuable timber, some yield dammar. *S. robusta* (sal) is native to the seasonal rain forests of India, and is much planted as coppice. According to tradition the Buddha died beneath one. There are about 180 species, in several rather distinct groups. They occur in seasonal and evergreen tropical rain forest, and are native from Sri Lanka to S. China and the Moluccas. They are abundant and have many sympatric species in W. Malesia.

Shorea albida (alan; family Dipterocarpaceae) Huge tree, mainly of the peat-swamp rain forests of N. Borneo, which is remarkable for its occurrence in extensive, pure stands, its large range, and the density of its timber, which is used for light construction, furniture, or packing cases.

shorebug *See* Saldidae.

shore crab *See Carcinus maenas*.

shoreface The subtidal coastal zone between the low-water mark and a depth of about 10–20 m. The lower limit of the shoreface corresponds to the position at which waves begin to affect the sea-bed (wave base), and therefore wave action governs the processes active in this area.

shore lark (*Eremophila alpestris*) *See* Alaudidae.

shore platform (wave-cut bench, wave-cut platform) Intertidal bench cut into a land mass by the action of waves and associated processes. It is terminated landward by a sea cliff, and slopes gently seaward at about 1°.

short-day plant Plant in which flowering is favoured by short days and correspondingly long nights. There are two groups of such plants: some species in which there is an absolute requirement for these conditions for the onset of flowering, and other species in which flowering is merely hastened by them.

short-eared owl (*Asio flammeus*) *See Asio*.

shorthead *See Breviceps adspersus*.

short-horned grasshopper *See* Acrinidae.

short-jawed mastodont An offshoot of the gomphotheres, the short-jawed mastodonts first appear in the Miocene and survived in N. America until about 8000 years ago. Some of the Pliocene representatives, belonging to the *Anancus* genus, strongly resembled the straight-tusked elephants of the Pleistocene.

shortnosed tripodfish (*Triacanthus brevirostris*) *See* Triacanthidae.

short-winged crickets *See* Gryllidae.

shortwings *See Brachypteryx*.

shot-hole borer *See* Bostrichidae.

shovelnose ray *See* Rhinobatidae.

shower Precipitation of short duration, associated with convective clouds, which do not usually form a continuous cover of the sky. Intensity varies, e.g. showers may be slight, moderate, or heavy. Hail or snow may form part of the precipitation.

shred In forestry, to remove the branches from a standard tree.

shrews *See* Soricidae.

shrikes 1 *See* Laniidae; and *Lanius*. 2 (bushshrikes) *See Tchagra*.

shrike-vireos *See* Vireonidae.

shrimp eel (*Ophichthus gomesi*) *See* Ophichthidae.

shrimpfish *See* Centriscidae.

shrimps 1 *See* Crustacea; and Decapoda. 2 (mantis shrimps) *See Squilla mantis*; and Stomatopoda.

shrub Perennial woody plant whose branches spring from the roots or at ground level. It is distinguished from a tree by its lower height and multiple stems. It may be deciduous (e.g. hawthorn) or evergreen (e.g. holly).

shurin Period of autumnal rains, occurring from September to October over much of Japan, and brought by Pacific low-pressure systems and typhoons.

Si *See* silicon.

sial The granitic layer of the crust containing relatively high concentrations of silica and alumina.

Sialidae (alderflies; subclass Pterygota, order Megaloptera) Family of insects which are similar to the Corydalidae, but are usually much smaller and lack ocelli. They are blackish-grey, resemble lacewings, and are found near ponds or streams, where their larvae develop. The larvae are similar to those of the Corydalidae, but lack hooked, anal prolegs, and have a terminal filament.

siamang *See* Hylobatidae.

Siamese fighting fish (*Betta splendens*) *See* Belontiidae.

siamweed (*Eupatorium odoratum*) *See Eupatorium*.

sib Shortened form of 'sibling'.

Siberian high The region of high average pressure in the colder seasons of the year over Siberia. The intensity of the high pressure is increased by the density of the very cold air at the surface over the Siberian plains.

sibling Offspring of the same parents; a brother and/or sister.

sibling species Species that are identical in outward appearance or very nearly so. Despite the similarity, however, they qualify as species by being reproductively isolated.

sibship All the siblings in a family.

sicula The skeleton of the initial zooid of a graptolite colony. *See also* Graptolithina.

Sida (family Malvaceae, tribe Abutileae) Genus of small shrubs and herbs, mostly covered in hairs. The leaves are simple, toothed or lobed, alternate, with stipules. The flowers are solitary, or held in terminal spikes or heads, and are usually yellow, orange, or white. They are regular and bisexual. The calyx is five-toothed, the corolla of five free petals. The many stamens are united into a tube at the base and are joined to the corolla. The ovary is superior, with five unilocular carpels. The mature carpels form the schizocarps, often with a beak or bristle. Several species are grown as ornamentals. There are about 200 species, found in all temperate regions, but centred in America.

side-necked turtles *See* Pleurodira.

siderite (chalybite, spathose iron) Mineral, specific gravity 3.8–4.0, hardness 3.5–4.5, chemical composition $FeCO_3$, whose name is derived from *sideros*, the Greek for 'iron'. Massive siderite is a widespread mineral in sedimentary rocks, especially clays and shales where it is concretionary and makes clay into ironstone. It is also found as a gangue mineral in hydrothermal veins together with other metallic ores (e.g. pyrite, chalcopyrite, and galena) and as a replacement mineral in limestone. It is distinguished by its rhombohedral form and its specific gravity. It will dissolve slowly in cold, dilute hydrochloric acid, which will effervesce when warmed. It is grey to grey-brown or yellowish-brown, and is translucent when pure. It has a white streak, and a vitreous lustre. It has an uneven fracture. It crystallizes in the trigonal system. It is rhombohedral in habit, with curved faces, but is also massive, granular, fibrous, compact, botryoidal, and earthy in habit.

Siderocapsaceae Family of bacteria, characterized by the ability to deposit iron and/or manganese oxides in material surrounding the cells. There are several genera, found in aquatic environments rich in iron.

sidewinder *See Crotalus cerastes*.

Siegennian *See* Devonian.

Sierra wave *See* lee waves.

sifaka *See* Indridae.

Siganidae (rabbitfish, spinefoot; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, which have an oval-shaped body; a long-based, continuous, dorsal fin; and an anal fin including seven spines. The pelvic fins have two spines, separated from the three soft rays. Although these fish are considered edible, the numerous spines can inflict painful stings (hence the name 'happy moments' reserved for these fish in N. Australia). There are about 10 species, which include *Siganus chrysospilos* (gold-spotted spinefoot), 38 cm, found in the Indo-Pacific region.

Siganus chrysospilos (gold-spotted spinefoot) *See* Siganidae.

sigma-t density Measure of the density of a sea-water sample measured at atmospheric pressure, i.e. at the sea surface. It is defined as (density -1) $\times$ 1000, where the density is measured in g/cm^3. Thus sea-water at 0 °C and 35 parts per thousand salinity has a density of 1.028 g/cm^3, or a sigma-t density, at a pressure of 1 bar, of 28.

sigmoid growth curve *See* S-shaped growth curve.

significant wave height The average height of the highest one-third of waves in a given group of waves. This height is usually used as a standard when recording the wave characteristics of a given area.

sign stimulus Part of a stimulus that is sufficient to evoke a behavioural response in an animal (e.g. the patch of red colour that provokes an aggressive reaction in *Erithacus rubecula*, the European robin.

silage (ensilage) Feedstuff for livestock, prepared from green crops (e.g. grass); the crops are stored in a pit or silo and the bacteria present on the plants carry out fermentation, the products of which preserve the plant material from further decay and loss of nutritional value.

silcrete *See* duricrust.

silent allele (null allele) In genetics, an allele that has no detectable product, and so is not expressed in a phenotype.

silex *See* flint.

silicates The most important and abundant group of rock-forming minerals, containing silicon and oxygen combined chemically with various metallic elements. They are chemically weathered to produce clay minerals.

siliceous Containing silica. Some kinds of wood are siliceous, and therefore hard to work.

siliceous ooze Fine-grained pelagic deposit of the deep-ocean floor with more than 30% siliceous material of organic origin. Radiolaria and diatom remains are the major constituents of the siliceous oozes, which tend to occur at depths in excess of 4500 m.

silicon (Si) An element which is helpful to or required by certain plants in small quantities. It does not seem to play a role in metabolism but some plants accumulate a large amount in the walls of epidermal and vascular tissues, and thereby reduce water loss and retard fungal infection.

silkcotton (samul) *See Bombax*.

silk moths *See* Bombycidae.

silky flycatchers *See* Bombycillidae.

silky oak (*Grevillea robusta*) *See Grevillea*.

sill In geology, a tabular igneous intrusion having concordant surfaces of contact.

Sillaginidae (southern whiting; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have an elongate, almost cylindrical body, a small mouth, and two separate dorsal fins which are of about equal size. The second dorsal and the anal fin are about equal in length. The largest and most highly prized species in the family is *Sillaginoides punctatus* (King George whiting), 70 cm, of temperate Australian waters. Often travelling in schools, southern whiting are found in the Indo-Pacific region. There are about seven species. They are not related to the northern whiting (family Gadidae).

Sillaginoides punctatus (King George whiting) *See* Sillaginidae.

sillimanite Mineral, specific gravity 3.3, hardness 6.5–7.5, and with the chemical composition Al_2SiO_5, named after the American mineralogist B. Silliman. It typically occurs in schists and gneisses as a result of high-grade metamorphism. It is distinguished by its fibrous habit. It can be colourless, white, yellowish, or brown, and has a vitreous lustre. It crystallizes in the orthorhombic system. The crystals commonly occur as elongated prismatic forms, but also as fibrous and felted masses. *See also* aluminosilicates.

Silphidae (carrion beetles, burying beetles, sexton beetles; class Insecta, order Coleoptera) Family of fairly large beetles, up to 30 mm long, which have smooth, generally red or black elytra. Some have exposed abdominal segments. They have prominent mandibles; the eyes are convex; the antennae are strongly clubbed. Their names are derived from their habit of burying corpses of small animals by excavating soil beneath them, using their mandibles and spined tibiae. Eggs are laid in connecting tunnels and larvae are fed by the female on carrion or associated fly larvae. *Silpha atrata* preys on snails, while others feed on caterpillars and root crops.

silt (pedol.) 1 Mineral soil particles that range in diameter 0.02–0.002 μm in the international system or 0.05–0.002 μm in the USDA system. 2 A class of soil texture.

Silurian Third of six periods of the Palaeozoic Era, beginning 430 million years ago and terminating 35 million years later. The end of the period is marked by the climax of the Caledonian orogeny and the filling of several Palaeozoic basins of deposition.

Siluridae (wels; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Family of freshwater catfish which have elongate, scaleless bodies, a somewhat conical head with two pairs of barbels near the mouth, a very long anal fin, and a forked tail-fin. The single dorsal fin is very small. The family contains many species, including *Kryptopterus bicirrhis* (glass catfish), 10 cm, which is a transparent, popular aquarium fish, and also *Silurus glanis* (giant wels), 3.6 m, from Europe, which is considered a commercially important fish. Siluridae are distributed in the northern hemisphere, from Europe to Indonesia.

Siluriformes Order of bony fish including all the catfish. This very large order comprises some 2000 species of marine and freshwater fish, belonging to about 31 families. The order was formerly known as Nematognathi.

Silurus glanis (giant wels) *See* Siluridae.

silver biddy *See* Gerreidae.

silverbills *See Lonchura*.

silverfish (subclass Apterygota, order Thysanura) Common name for members of the family Lepismatidae; it is sometimes used to denote any member of the Thysanura. *See also* Lepismatoidea.

silver glance *See* argentite.

silver hatchetfish (*Argyropelecus lychnus*) *See* Sternoptychidae.

silver iodide Substance used in fine particle form to act as nuclei in cloud seeding.

silver-leaf Disease affecting a number of ornamental and fruit trees, especially plum. The characteristic symptom is the silvery sheen that appears on the leaves of infected trees. Branches show a dark brown discoloration and die back. The causal agent is *Stereum purpureum* (*Chondrostereum purpureum*).

silversides (sand smelts) *See* Atherinidae.

silver thaw Phenomenon resulting from the formation of ice on cold surfaces, e.g. due to rain, during a period of rapid thaw after a severe frost. *See also* glaze.

silviculture The cultivation of forest trees, or woodland management for timber and other wood products. Sometimes the term is used interchangeably with 'forestry', but usually it implies a more holistic approach.

sima The layer of the Earth's crust lying below the sial and composed of basic rocks rich in silicon and magnesium.

Simaroubaceae Family of trees and shrubs, many of which have a bitter taste and contain compounds of medicinal use. The leaves are simple or pinnate, the stalks often jointed. The flowers are small, regular, and tri- or pentamerous, with an intrastamenal disc. The fruit is often drupe-like. There are 31 genera, with 200 species, scattered throughout the tropics and northern subtropics.

simian virus 40 Virus isolated from tissues of the African green, rhesus, and other monkeys. It can also infect humans. It appears not to cause disease in humans or monkeys, but it can cause tumours in new-born animals.

Simiiformes *See* Anthropoidea.

similarity coefficient Any measure of the similarity of two samples. In ecological work, the similarity index devised in 1920 by H. A. Gleason has been widely used. This measures similarity as $C = 2W/(a+b)$, where a and b are the quantities of all the plants (or other commodity) found in the two stands, or other units to be compared, and W is the sum of the lesser values for those species common to both units. Complete similarity thus scores 1, complete dissimilarity 0. *See also* affinity index.

simoom Regional wind in desert areas of Africa and Arabia. The wind blows for only a short period at a time and its whirlwind effect carries sand and brings very hot, dry conditions.

simple eye Eye consisting of a single ocellus. Such eyes are found in adult insects, and in the larvae of hemimetabolous insects. Usually there are three, arranged triangularly on the head. Simple eyes are not thought to be involved in the formation of images, but act only as monitors of the level of light intensity.

simple sorus *See* gradate sorus; and sorus.

Simplicidentata *See* Rodentia.

simplicidentate Applied to the condition in which the single pair of upper incisors have persistent pulps.

Simuliidae (black flies, buffalo gnats; class Insecta, order Diptera, suborder Nematocera) Small family of small, stout flies which have short legs and elongated mouthparts. The wings are broad, with thickened anterior veins. The antennae are short, and 11-segmented, and ocelli are absent. In males the upper eye facets are larger than the lower, a condition known as 'holoptic'. Females of some species are active blood-suckers, especially *Simulium damnosum* of Africa, which carries the nematode *Onchocera*, the cause of filariasis. Adults are never found far from running water, as their larvae are aquatic and prefer swift-flowing, well-oxygenated water. The larvae feed by filtering detritus and planktonic organisms from the water by means of a series of stout bristles around the mouth. The family has a worldwide distribution and in some countries is of great economic importance. More than 1300 species have been described.

***Simulium damnosum* complex** *S. damnosum* may be considered as a group of very closely related, and often morphologically indistinguishable, sibling species, hence 'complex'. The species are found distributed widely over much of Africa. *See also* Simuliidae.

Sindora (family Leguminosae, subfamily Caesalpinoideae) Genus of big trees which have pinnate leaves. There are four sepals, one petal, and nine fused stamens and one free stamen. The fruit is a flat, rounded, woody, indehiscent, spiny pod with one big, flat seed (or several such) seated on a big, hard aril. The timber is valuable (sepetir). There are 20 species, occurring in SE Asia, and one species in W. Africa.

single (store) To allow a single pole from a coppice stool to grow on to form a standard tree.

singularity Term applied in meteorology to short seasonal episodes lasting a few days and commonly occurring about specific dates of the year. One example is the periods of fine, dry, warm weather commonly occurring in September and early October in Britain and central Europe, and known as 'old wives' summer' (or 'Indian summer'), which are due to slow-moving anticyclones.

sinkhole *See* doline.

sinking *See* downwelling.

Sinodendron cylindricum (small stag beetle) *See* Lucanidae.

Sino-Japanese floral region Part of Good's (1974) Boreal kingdom, which corresponds geographically with the Sino-Himalayan-Tibetan mountains, N. and C. China, and Japan. The region is differentiated by more than 300 endemic genera, and contains in fact the richest flora in the northern temperate zone. A vast number of garden plants are native to the region, as are a number of important economic plants.

sinuate Curved; having a wavy or indented margin.

sinus A space, found for example between the lobes of a plant leaf, or in certain bones of the face of a mammal where they are filled with air and connect with the nasal cavity. In certain pelecypods, a recess or embayment in the pallial line; forms with a sinus are generally burrowers.

siphonaceous (siphoneous) Applied to algae in which the thallus is not divided up by septa, i.e. the many nuclei are not compartmentalized into cells. The typical siphonaceous alga has a large central vacuole surrounded by a layer of protoplasm, containing nuclei and chloroplasts, which lines the cell wall.

Siphonales *See* Codiales.

siphonate Applied to the aperture of a gastropod shell when a canal or notch for the siphon is present.

siphoneous *See* siphonaceous.

Siphonocladales (class Chlorophyceae) Order of green algae, in which the thallus is multicellular, with multinucleate cells and reticulate chloroplasts.

They are found in marine environments, mainly in tropical regions.

Siphonophora (Siphonophorida, siphonophores; class Hydrozoa) Order of Cnidaria whose members produce highly polymorphic colonies without skeletons and without free, sexual medusae. They consist of floating or free-swimming assortments of polyploid and medusoid individuals attached to a stem.

Siphonophorida *See* Siphonophora.

siphonozoid In some Anthozoa, a polyp that generates water currents.

siphuncle A long tube present in those cephalopods that possess external shells. It runs internally, through all the chambers, and contains the siphuncular cord of body tissue, extending from the visceral mass through a perforation in each septum of the shell. The siphuncle releases gas into the empty chambers of the shell, making it buoyant.

Sipunculida (peanut worms) Phylum of coelomate worms which lack body segmentation. They are cylindrical in shape, and the mouth is surrounded by small tentacles. The nervous system includes a brain, and sense organs are present. Males and females occur. They are exclusively marine; all are benthic; and most feed on detritus, although some are carnivores. They are first recorded in the Middle Devonian.

Sirenia (sea cows, mermaids; cohort Ferungulata, superorder Paenungulata) Order of herbivorous ungulates which have adapted to a fully aquatic life. The body is streamlined, thick-skinned, and has a thick layer of blubber. The forelimbs are pentadactyl; the digits are joined, forming large paddles, but considerable movement is possible at the wrist and elbow and in the digits. There are no hind limbs, and the pelvic girdle is vestigial. The tail is modified to form a horizontal fin. The ribs are numerous and form a barrel-shaped cage extending far back in the body, and the diaphragm is oblique, so the lungs are large. The bones are heavy, with little marrow (pachyostosis). The skull is large, but the braincase is small. The young are born in the water and suckle from pectoral teats. Fossil sirenians are known from the Eocene, in Egypt and Jamaica. Probably they appeared first in Africa, from the stock that also gave rise to the proboscideans; and the two surviving families, Dugongidae and Trichechidae, diverged possibly before the end of the Eocene and so are different in many ways from one another.

Sirenidae (sirens; class Amphibia, order Urodela (Caudata)) Family of permanently larval, aquatic amphibians which have an eel-shaped body, short forelimbs and tail, no hind limbs or pelvis, no teeth, and no eyelids. The jaws have horny plates. Gills are retained throughout life. Sirens swim and burrow in streams and ditches, and may occasionally move across land. There are three species, occurring in SE USA.

sirens *See* Sirenidae.

Sirex gigas *See Uroceras gigas.*

Sirex noctilio *See* Siricidae.

Siricidae (horntails, woodwasps; suborder Symphyta, superfamily Siricoidea) Family of Hymenoptera which have very large ovipositors used in wood boring. Most are 25–35 mm long, but some may be up to 50 mm. Adults are usually black or brownish, and sometimes metallic or with dark wings. The abdomen has an apical, large, dorsal spine, the ovipositor of the female being positioned below the spine. Eggs are laid under the surface, the larvae penetrating deeply into the host tree (particularly in coniferous species). The larvae have a long developmental period, sometimes emerging as adults after the timber has been used for building or furniture construction. Some species, e.g. *Sirex noctilio* on *Pinus radiata* in Australia, can cause serious economic damage.

sirocco *See* scirocco.

sisal *See Agave.*

siskins *See Carduelis.*

Sisoridae (class Osteichthyes, subclass Actinopterygii, order Siluriformes) Small family of freshwater catfish which have a robust yet depressed body, small eyes, broad-based barbels, and relatively large pectoral fins. The flattened belly side and the pectoral fins help the fish keep its position in the fast-flowing mountain streams of the Asian highlands.

sister chromatid exchange (SCE) An event, similar to crossing-over, that can occur between sister chromatids at mitosis and meiosis. It may be detected in harlequin chromosomes (sister chromatids that stain differently so that one appears dark and the other light).

sister groups The twin products of cladogenesis. Under the rules of phylogenetic systematics, sister groups must be classified at the same rank taxonomically.

site In genetics, the position within a cistron occupied by a mutation.

Sitka spruce (*Picea sitchensis*) *See Picea.*

Sitona lineatus (bean weevil, pea weevil) *See* Curculionidae.

Sitophilus granarius (grain weevil) *See* Curculionidae.

Sitta (nuthatches; family Sittidae) Genus of small birds, most of which have blue-grey upper-parts and a black crown or eye stripe. They have short tails, strong feet, and a long, pointed, tapering bill. They inhabit woodland and rocky areas, and climb up and down trees and rocks to feed on insects, spiders, seeds, and nuts. They nest in tree and rock cavities. There are 21 species found in Europe, Africa, Asia, and N. America.

sittellas *See* Daphaenosittidae.

Sittidae (nuthatches; order Passeriformes) Family that comprises the one genus *Sitta*. Tichodromidae and Daphoenosittidae are sometimes placed in this family.

Sivapithecus Genus of early hominoid Primates, which probably includes the so-called *Ramapithecus*. They are known from E. Africa, SE Europe, Turkey, Arabia, Pakistan, N. India, and S. China, from the Middle and Late Miocene, 15–8 million years ago. The genus may include ancestors of great apes and humans, but certainly early relatives of the orang-utan have been identified among species of the genus. Although there are similarities with human teeth, these are probably misleading, and *Sivapithecus* is now regarded as an ape that was ancestral either to the orang-utan alone, or to all living great apes and humans.

Sivatherium *See* Giraffidae.

six-lined perch (*Grammistes sexlineatus*) *See* Grammistidae.

skate *See* Rajidae.

skiaphilic *See* sciaphilic.

skilfish (*Erilepsis zonifer*) *See* Anoplopomatidae.

skimmers *See* Rynchopidae.

skin beetle *See* Dermestidae.

skinks *See* Scincidae.

Skinner box In laboratory studies of animal behaviour, a cage in which an animal may learn that the performance of a particular activity (e.g. pressing a bar) is rewarded (e.g. with food) so that its behaviour may be conditioned. *See also* operant conditioning.

skip-jack *See* Elateridae.

skipper 1 (*Scomberesox saurus*) *See* Scomberesocidae. 2 *See* Hesperiidae.

Skomer vole *See* race.

skuas *See* Charadriiformes; and Stercorariidae.

skunk (*Memphitis*) *See* Mustelidae.

skunk bear (carcajou, glutton, wolverine, *Gulo gulo*) *See* Mustelidae.

sky-view factor The extent of sky observed from a point as a proportion of the total possible sky hemisphere.

slant-faced grasshoppers *See* Acrididae.

slash-and-burn agriculture *See* shifting cultivation.

slate Low-grade, regionally metamorphosed rock, which is highly fissile and fine-grained. The fissility (cleavage) results from the parallel alignment of numerous fine micas induced by compressive tectonic deformation.

slaters *See* Crustacea; and Isopoda.

slave-making ant *See* dulosis; and *Polyergus rufescens*.

sleeper *See* Eleotridae.

sleeping sickness (trypanosomiasis) Chronic disease of mammals, caused by infection by the flagellate protozoon *Trypanosoma*, which is transmitted by blood-feeding insects, especially *Glossina* in Africa. In humans there are two main African forms of the disease, Gambian and Rhodesian, caused by *T. gambiense* and *T. rhodesiense* respectively. Both forms affect chiefly the brain—hence the symptoms that give the disease its name. Symptoms include intermittent fever, eventually followed by the characteristic symptoms of malaise and sleepiness. Treatment is difficult because of constant changes in the active form of the protozoon.

sleep movements *See* nictonasty.

sleepy grasses *See Stipa*.

sleet Precipitation in the form of a mixture of rain and melting snow. In N. America the term is applied to ice pellets of less than 5 mm in diameter.

slender blind snakes *See* Leptotyphlopidae.

slick Quiescent area on the surface of a water body. The relative smoothness of these areas compared to adjacent waters is usually caused by a thin surface film of oil which changes the surface tension.

slickenside 1 The surface of a fault that has been polished and grooved by the friction of displacement. It may be coated by a mineral, often quartz, which itself shows striations in the direction of fault movement. 2 The similarly polished surface left by the passage of a mud slide. 3 In soils, the natural crack surfaces produced by swelling and shrinking in clayey soils that are high in swelling clays.

sliding-filament theory Hypothesis proposed by Huxley and Hanson to explain the mechanism of contraction of striated muscle. It proposes that the parallel, interdigitated thick myosin and thin actin filaments slide past one another to varying degrees to shorten the muscle. This is brought about through the sequential formation of cross-bridges between the actin and myosin molecules such that the filaments move past one another in a ratchet-like manner. The energy for these processes is provided by the hydrolysis of ATP.

slimehead *See* Trachichthyidae.

slime mould Type of eukaryotic micro-organism in which either a plasmodium or pseudoplasmodium is formed. Slime moulds may resemble fungi superficially, and traditionally are included in mycological classification schemes, although probably they are not related to fungi.

sling psychrometer *See* whirling psychrometer.

slipmouth *See* Leiognathidae.

slipper animalcule A *Paramecium* species.

slit-faced bat (*Nycteris*) *See* Nycteridae.

Sloanea (family Elaeocarpaceae) Genus of trees with pinnately-nerved leaves, with stipules. The flowers are regular, bisexual, axillary or terminal, and usually borne in racemes or panicles. There are four or five sepals, which are usually free but are occasionally united into a short tube; the petals are absent, or rarely up to four in number and smaller than the sepals. The numerous stamens are free. The ovary is superior with four or five locules, each with many ovules. The style is simple. The fruit is a capsule, covered in stiff bristles, with endospermic seeds. The genus was formerly included in

the family Tiliaceae. There are about 120 species, found in tropical Asia, America, and E. Australia. Two species are useful timber trees.

slop Poles produced by coppice.

sloth *See* Bradypodoidea.

slow worm *See Anguis fragilis*.

slump Variety of landslide characterized by rotational slip along a concave-up failure surface. The upper unit of the slump is typically tilted back, and surface water may be retained in the depressed zone. The slump may be caused by basal undercutting, or by the over-steepening of artificial embankments. It is normally found in a uniform, relatively weak material, e.g. clay.

small-eared dog (*Atelocynus microtis*) *See* Canidae.

smallpox (variola major) Severe, acute, highly infectious disease of humans which involved fever, rash, and prostration. The mortality rate was high. The causal agent was the variola major virus, a poxvirus. Once an important human disease, smallpox was declared eradicated from the world population in 1977.

small stag beetle (*Sinodendron cylindricum*) *See* Lucanidae.

small tortoiseshell butterfly *See Aglais urticae*.

smaltite Mineral, specific gravity 5.7–6.9, hardness 5.5–6.0, and with the chemical composition $(CoNi)As_2$. It is found in veins with cobalt and nickel minerals, native silver, arsenopyrite, and calcite. It is tin-white to grey with an iridescent tarnish, and has a grey-black streak, and a metallic lustre. It crystallizes in the cubic system. The crystals are cubes and octahedra, and it is also massive and granular. It is an ore mineral for cobalt and nickel.

smelt *See* Osmeridae.

Smilax (family Smilaceae) Genus of slender, often spiny, woody climbers, which are net-veined monocotyledons, the leaves having a pair of basal, spiralling tendrils. The flowers are held in umbels, and are dioecious. Sarsparilla is the dried roots of several American species. There are 300 species, with a pantropical distribution.

Smithornis (broadbills; family Eurylaimidae) Genus of small, dull, brown and grey birds which have very broad bills, and some of which have rufous breast markings. They inhabit forests, feed on insects many of which are caught in flight, and build nests suspended from branches just above the ground. There are three species, found in Africa.

smithsonite (calamine) Mineral, specific gravity 4.4, hardness 4.5, chemical composition $ZnCO_3$, named after the British mineralogist James L. M. Smithson (founder of the Smithsonian Institution). It occurs in the oxidized zone of zinc ore deposits and is commonly associated with sphalerite, galena, and calcite. It also occurs as a replacement in limestone, and in hydrothermal veins. It is distinguished by its solubility in dilute hydrochloric acid, with effervescence, and its high specific gravity. It has a very variable colour which can be shades of grey, brown, or greyish-white, but green, brown, and yellow types also occur. It has a grey streak, and a vitreous lustre. It crystallizes in the trigonal system. Crystals are rare, but when they develop they are rhombohedral with curved faces. More usually it occurs as botryoidal and stalactitic masses. The green variety of the mineral is used to make ornaments.

smog Naturally occurring fog mixed with visible (smoke) and/or invisible pollutants. *See also* photochemical smog.

smoke bush (*Cotinus coggygria*) *See Cotinus*.

smolt Stage in the life of salmon-like fish in which the sub-adult individuals acquire a silvery colour and migrate down the river to begin their adult lives in the open sea. *See also* parr.

smooth-barked apple (*Angophora costata*) *See Angophora*.

smooth hound (*Mustelus mustelus*) *See* Carcharhinidae.

smooth newt *See Triturus vulgaris*.

smooth prowfish (*Aetapcus vincenti*) *See* Pataecidae.

smooth razorfish (*Centriscus aristatus*) *See* Centridae.

smooth snake *See Coronella austriaca*.

smooth stingray (*Dasyatis brevicaudata*) *See* Dasyatidae.

smudge Disease which can affect onions, shallots, and leeks. Dark patches, often in the form of concentric rings, appear on the bulbs. The causal agent is the fungus *Colletotrichum circinans*.

smudging The burning of materials (e.g. oil) to produce a smoke layer that reduces the effect of radiation cooling of the air above the ground surface. It is used as a protective measure, e.g. in fruit-growing areas, especially in frost hollows.

smut Plant disease caused by a fungus of the order Ustilaginales. Many types of plant can be affected, but smuts are particularly important in cereals and other grasses. The symptoms include the formation of masses of black soot-like spores, and infected plants often show some degree of distortion.

snaggletooth *See* Astronesthidae.

snake ancestors *See* Lanthanotidae.

snake blenny *See* Ophiclinidae.

snake eel *See* Ophichthidae.

snakeflies *See* Raphidiidae.

snake-footed bat *See* Myzopodidae.

snakeheads *See* Channidae.

snake lizards *See* Pygopodidae.

snake mackerel (*Gempylus serpens*) *See* Gempylidae.

snake-necked turtles *See* Chelidae.

snakes *See* Serpentes.

snapdragon (*Antirrhinum majus*) *See Antirrhinum*.

snapper *See* Lutjanidae.

snapping beetle *See* Elateridae.

snapping turtles *See* Chelydridae.

snipe 1 *See Gallinago*; and Scolopacidae. 2 (painted snipe) *See* Rostratulidae.

snipe eel *See* Nemichthyidae.

snipefish *See* Macrorhamphosidae.

snipe flies *See* Rhagionidae.

snook (*Centropomus undecimalis*) *See* Centropomidae.

snout beetle *See* Curculionidae.

snout butterflies *See* Libytheidae.

snowflake Growth of ice crystals in a varied array of shapes. Very low temperatures usually result in small flakes; formation at temperatures near freezing point produces numerous crystals in large flakes.

snow-gauge Measuring device for collecting snowfall and ice precipitation. The recording is usually made after the snow or ice has melted.

snow grain Small ice particle precipitated as a usually flattish grain.

snow leopard (*Panthera uncia*) *See Panthera*.

snow line The lower limit of permanent snow cover. The height of the line varies with latitude; locally it also varies with aspect, because of the relationship to prevailing winds and quantity of snow deposited, and to summer temperatures, etc.

snow-patch vegetation In tundra and to a lesser extent in alpine environments, late-melting snow patches exert a marked influence on the vegetation. Vegetation that occurs beneath the small snow patches and the peripheral parts of large ones is protected from the rigours of winter, but as the snow melts comparatively early in the summer months, the vegetation is also able to capitalize on most of the growing season: in these situations, therefore, it is rather luxuriant. Conversely, the larger snow patches which melt well into or towards the end of the short growing season tend greatly to restrict the development of vegetation.

snow-worm *See* Cantharidae.

soapfish *See* Grammistidae.

soapstone *See* talc.

soboliferous Forming clumps.

sociability scale Five-point scale used in vegetation analysis to indicate the degree of clumping or gregariousness of an individual plant species, obtained as a visual impression. '1' on the scale indicates a shoot growing singly; '5' indicates shoots growing in large mats or pure populations.

social wasps (superfamily Vespoidea, family Vespidae) The common name most usually applied to members of the vespid subfamilies Vespinae, Rhopalidiinae, Polistinae, and Polybiinae.

sociobiology The integrated study of social behaviour, based on the premiss that all behaviour is adaptive. It gives special emphasis to social systems considered as ecological adaptations, and attempts a mechanistic explanation of social behaviour in terms of modern biology and, in particular, evolutionary theory.

sodalite Mineral, specific gravity 2.1–2.3, hardness 5.5–6.0, chemical composition $Na_8(AlSiO_4)_6Cl_2$. It occurs as a primary constituent of alkaline igneous rocks, especially extrusive syenites and nephaline-syenites. It is grey with a yellowish tinge, but often colourless or occasionally blue, and it has a vitreous to greasy lustre. It crystallizes in the cubic system. The crystals are rhombododecahedra, and occasionally cubes, and also massive, granular aggregates.

soda nitre *See* Chile saltpetre.

sodication In soils, an increase in the percentage of exchangeable sodium. Sodium adsorbs on to soil cation-exchange sites, causing soil aggregates to disperse, which closes soil pores and renders the soil impermeable to water. *See also* sodium adsorption ratio.

sodic soil 1 Soil with a sodium content sufficiently high to interfere with the growth of most crop plants. 2 Soil with more than 15% exchangeable sodium.

sodium (Na) Element found in all terrestrial plants. It is not essential except in certain C4 salt-tolerant plants, but it has a role in crassulacean acid metabolism.

sodium adsorption ratio (SAR) The tendency for sodium cations to be adsorbed at cation-exchange sites in soil at the expense of other cations, calculated as the ratio of sodium to calcium and magnesium in the soil (as the amount of sodium divided by the square root of half the sum of the amounts of calcium and magnesium, where ion concentrations are given in milli-equivalents per litre). A low sodium content gives a low SAR value. In practice, allowance must be made for other reactions within the soil that do not involve sodium but that affect concentrations of calcium and magnesium. The SAR value is most likely to be changed by irrigation water.

sodium-coupled transport The entry of a metabolite into a cell against a concentration gradient, where this entry is coupled to the movement of sodium across the membrane. Sodium readily enters cells because of the concentration of its ions outside the cell membrane which is high compared with that inside. It is thought that carriers exist that can bind to sodium, so exploiting this feature, and also to a metabolite (such as glucose), which is thereby carried across the membrane.

sodium pump Mechanism found in higher animal cells that is responsible for the transport of sodium and potassium ions across membranes and against concentration gradients. Its operation is dependent upon the provision of cellular ATP and the enzyme sodium / potassium-ATPase, and its net results are low levels of sodium ions and high levels of

potassium ions inside the cell (compared with those outside).

sodoku *See* rat-bite fever.

soft corals *See* Alcyonacea.

soft rot Any of a range of plant diseases in which the tissues of the infected plant are softened or even liquefied, typically becoming slimy and malodorous. A common cause of soft rot in carrots and other vegetables is *Erwinia carotovora*.

soft-shelled turtles *See* Trionychidae.

soil The natural, unconsolidated, mineral and organic material occurring on the surface of the Earth; it is a medium for the growth of plants.

soil air The soil atmosphere, comprising the same gases as in the atmosphere above ground, but in different proportions: it occupies the pore space of the soil.

soil association 1 Group of soils forming a pattern of soil types characteristic of a geographical region. 2 Mapping unit used to denote the distribution of soil types where the scale of the map does not require or permit the identification of individual soils. *See also* soil complex.

soil complex Mapping unit used to denote the distribution of soils: it is more precise than a soil association, and is used where soils of different types are mixed geographically in such a way that the scale of the map makes it undesirable, or impractical, to show each one separately.

soil conservation The protection of the soil by careful management, to prevent physical loss by erosion and to avoid chemical deterioration (i.e. to maintain soil fertility).

soil formation The action of the combined primary (weathering and humification) and secondary processes to alter and to rearrange mineral and organic material to form soil, involving the differentiation of soil profiles and the formation of loose soil from consolidated rock material. *See also* pedogenesis.

soil horizon Layer of soil, more or less parallel to the soil surface, that is physically, chemically, and/or biologically distinguishable from the layers above and below it.

soil management A variety of practices and operations with respect to soil that aid the production of plants; normally they are planned to allow for sustained yield in the future.

soil-moisture index *See* moisture index.

soil separates Size divisions of mineral particles (sand, silt, and clay) that comprise the fine earth, each particle being less than 2 μm in diameter.

soil series Basic unit of soil mapping and classification: all soils in a series have similar profile characteristics and have developed from the same parent material.

soil structure Grouping of individual soil particles into secondary units of aggregates and peds; this grouping is like an internal scaffolding of the soil.

soil survey Systematic examination and mapping of soil in the field.

soil variant Soil sufficiently different in properties from adjacent soils to warrant the use of a new series name, but occupying a geographical area too small to warrant the issuing of such a new name.

sola *See* solum.

Solanaceae Family of dicotyledonous plants, mostly herbs but some shrubs and trees, having normally alternate leaves, and regular flowers which are mostly pentamerous. The petals form a corolla tube, at least at the base. There are five stamens, alternating with the corolla lobes. The ovary is of two cells, sometimes four, with many ovules on axile placentas, and a terminal style. The fruits may be capsules or berries. The Solanaceae are an important family, containing many plants of major economic importance, such as *Solanum tuberosum* (potato), and *Lycopersicon esculentum* (tomato); also *Nicotiana tabacum* (tobacco), ornamentals (e.g. *Petunia hybrida* with showy flowers), and many poisonous genera and species rich in alkaloids (e.g. *Atropa belladonna*, deadly nightshade), some of which are used in medicine. There are some 75 genera, with 2000 species, cosmopolitan in distribution but centred in the tropics.

Solanocrinitacea (feather-stars; subclass Articulata, order Comatulida) Superfamily of extinct feather-stars, which possess a flat, cirrus-free, dorsal part of the centrodorsal plate. The cirrus sockets are large, the centrodorsal cavity small (less than one-fifth of the centrodorsal diameter). The superfamily is known from the Jurassic to Cretaceous.

Solanum (family Solanaceae) Genus of plants, with flowers in which the stamens are prominent, and converging into a cone, and the corolla lobes are spreading or reflexed. The genus includes *S. tuberosum* (potato), which is of complex hybrid origin, from the Andes, and is one of the world's major food plants. Some species have fruits with ornamental berries. There are some 1500 species, most of them tropical.

solar constant The mean intensity of the solar beam in free space (i.e. before penetrating the Earth's atmosphere) at the average distance of the Earth from the Sun. The intensity is not strictly constant for all the wavelengths of radiation involved. The amount of variability is still a subject of debate, but is certainly very small apart from the long-term development in the history of the Sun.

solarimeter Instrument for measuring solar radiation.

solar radiation Electromagnetic radiated energy from the Sun. This is the dominant energy input to the Earth and is intercepted by the atmosphere and absorbed at the surface. *See also* energy budget.

solar wind General term for the stream of high-energy particles emitted by the Sun. The 'wind' strength is thought to be greatest during periods of maximum solar activity.

soldier A sterile member, specialized for defence, of an ant or termite colony. The head is usually enlarged, and it or the tip of the abdomen may be used to block entrance holes to the nest (phragmosis).

soldier beetle *See* Cantharidae.

soldier flies *See* Stratiomyidae.

sole *See* Soleidae.

Solea solea (European sole) *See* Soleidae.

Soleidae (sole; class Osteichthyes, subclass Actinopterygii, order Pleuronectiformes) Fairly large family of mostly marine flatfish which have an oval-shaped body outline, with the dorsal fin originating well in front of the eyes, which are usually on the right side of the body. The small, twisted mouth is subterminal and located almost underneath the eyes. Soles are often found in shallow coastal waters. Several species, e.g. *Solea solea* (European sole), 40 cm, are of commercial importance. There are about 117 species, distributed worldwide in temperate and tropical seas.

Solemyoida (phylum Mollusca, class Pelecypoda) Order of pelecypods which have a shell with a homogeneous calcium carbonate microstructure. They are anisomyarian, with a greatly reduced anterior adductor muscle. The hinge is edentulous, and the gills protobranchiate. The valves are gaping, with the posterior end shorter than the anterior. They first appeared in the Devonian. There is only one extant genus, *Solemya*.

solenial *See* solenium.

Solenichthyes Alternative, older name for fish belonging to the order Syngnathiformes.

Solenichthys cyanopterus (blue-finned ghostfish) *See* Solenostomidae.

solenium (adj. solenial) In coelenterate polyps, a canal lined with gastrodermis that interconnects the gastric cavities.

Solenochilida (class Cephalopoda, subclass Nautiloidea) Small order of globose, nautiliconic cephalopods, in which the siphuncle is in a ventral position and the sutures are simple. The order contains only one family, the Solenochilidae, and ranges in age from Lower Carboniferous to the end of the Permian.

Solenochilidae *See* Solenochilida.

solenocyte In some Annelida, an excretory structure consisting of a tubule of parallel rods between which coelomic fluid enters to be moved by a single flagellum into the lumen of a nephridium.

Solenodon (alamiqui) *See* Solenodontidae.

Solenodontidae (alamiqui; order Insectivora, suborder Lipotyphla, superfamily Soricoidea) Family of fairly large (about 30 cm long), nocturnal insectivores in which the hair is coarse, and the tail is long and scaly. Each limb bears five digits with large, strong claws. The upper molars are zalambdodont, a feature that distinguishes them from other insectivores but which they share with the Tenrecidae. There are two species, *Solenodon paradoxus*, occurring only in Haiti and the Dominican Republic (Hispaniola Island), and *S. cubanus*, in Cuba, the latter sometimes being placed in a separate genus, *Atopogale*.

Solenogastres *See* Aplacophora.

solenostele The type of vascular cylinder found in stems of many ferns, in which there is a central stem and an outer cortex, and the vascular tissue is limited both internally and externally by a continuous sheath of special cells, called the endodermis. Woody xylem tracheids form the bulk of the cylinder. On its outer and inner faces, within the endodermis, there is a zone of phloem tissue. When leaves arise from the stem, breaks occur in the cylinder, and if the leaves are close-set this may result in the cylinder of vascular tissue becoming so broken that it forms a cylindrical network, rather than a solid cylinder. It is then called a 'dictyostele' (from the Greek *dictyon*, a net). Flowering plants have separate vascular bundles in the young stem, and though secondary growth of woody tissue may join these into a cylinder around the pith, there is never an internal endodermis as in a true solenostele.

Solenostomidae (ghost pipefish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Small family of marine fish which resemble sea-horses, but have a tube-like snout; a short body; a large tail-fin, and pelvic fins which in the female are fused to form a brood pouch. *Solenichthys cyanopterus* (blue-finned ghostfish), 15 cm, is distributed widely in the Indo-Pacific region. There are about five species.

Solidago (golden rod; family Compositae) Genus of perennial herbs, with stalkless, simple leaves, and small, yellow flower heads in panicles. The bracts of the involucre of the flower heads overlap in many rows. The heads have both yellow (female or neuter) ray-florets and bisexual disc-florets. The achenes are many-ribbed, and have a pappus of ciliate hairs. *S. canadensis* and *S. gigantea* are much grown in gardens for their showy, golden panicles of flower heads, but *Solidago* species are regarded as weeds in parts of the USA. There are some 120 species, mostly American, but some European and Asian.

solifluction Downhill movement of regolith that has been saturated with water. It was originally described in periglacial regions (*see* gelifluction), but the term was subsequently widened to include all environments. The thick regolith of the humid tropics is particularly prone to solifluction after intense rainfall.

Solifugae (windscorpions; class Arachnida) Order of arachnids in which the prosoma is divided into a proterosoma and two free segments. The abdomen is constricted anteriad, and the entire body is covered with long, sensory hairs. The chelicerae are much enlarged, chelate, and armed with teeth. The pedipalpi are leg-like, and their tarsi, as well as the tarsi of the first pair of walking legs, contain sensilla ampullacea (special pits bearing short, sensory hairs). The carapace bears a large pair of median eyes and there may be vestiges of lateral eyes. The

terminal segment of the last pair of walking legs bears racquet organs (malleoli) which contain sensory nerve endings. The tracheal system resembles that of the Insecta rather than Arachnida. Windscorpions have complex courtship behaviour, seemingly more advanced than that of scorpions but less advanced than that of spiders. Most species are crepuscular or nocturnal, and although none has specialized digging structures most of them construct burrows, and may aggregate in areas of high prey density, prey being caught by chase or ambush. Of the 800 or so species, six are found in Europe. Most, being desert dwellers, are found in India, the W. Indies, western USA, and N. Mexico.

soligenous mire *See* Aapa mires.

solitaires *See* Raphidae.

solitaria *See* locust.

solitary bees 1 The majority of bees, which are not social, i.e. there is no worker caste and the bees do not live in colonies. Each nest is the work of an individual female, and although nests may be aggregated, there is no co-operation among individuals. 2 (solitary mining bees) *See* Andrenidae.

solitary wasps (order Hymenoptera, suborder Apocrita) Name generally given to wasps that do not live in colonies, e.g. potter wasps, mason wasps, and spider-hunting wasps. Mason wasps make nests from particles of sand and soil stuck together with saliva. The nests are found in the soil, in crevices in wood, and in stone walls, and are individually provisioned with paralysed prey for the larva.

solodic soil Leached, formerly saline soil, associated with semi-arid tropical environments, in which the A horizon has become slightly acid, and the B horizon is enriched with sodium-saturated clay. The term was used in soil classification systems derived from early Russian systems based on the work of V. V. Dokuchaev, but is not included in the USDA Soil Taxonomy.

solonetz Mineral soil at a transitional stage of leaching, or solodization of saline soils, in semi-arid, tropical environments, which has a sandy, acid A horizon and a B horizon partially enriched with sodium-clay. The term was used in systems of soil classification that are being superseded by the USDA Soil Taxonomy, in which solonetz soils fall within the order Aridisols.

solstice The time of most northerly or southerly declination of the Sun from the equator. The northern hemisphere summer solstice is around June 22 and the winter solstice around December 22. The solstice dates are reversed for the southern hemisphere.

soluble RNA *See* s-RNA.

solum (pl. sola) The upper part of a soil profile, above the parent material, in which processes of soil formation occur, and within which most plant roots and soil animals are found.

solution pipe Cylindrical, near-vertical pipe developed at a joint intersection in a karst environment. It is caused by a local increase in the rate of carbonation resulting from enhanced drainage.

Somateria (eiders; family Anatidae) Genus of heavy-bodied sea ducks which have large heads and deep-based bills. Males are black and white, females are brown. Eiders inhabit coasts and estuaries, breeding on shores or inland tundra. They feed on molluscs and crustaceans obtained by diving, and nest on the ground. The nest lining of down feathers is used by humans to fill eiderdowns. There are three species, found in northern regions of Europe, Asia, and N. America.

somatic cell *See* somatic cell hybrid.

somatic cell hybrid Hybrid cell resulting from the fusion of two somatic or body cells (i.e. cells that are not destined to become gametes, whose genes will not be passed on to future generations).

somatic crossing-over In genetics, crossing-over during mitosis of somatic cells such that parent cells heterozygous for a given allele, instead of giving rise to two identical heterozygous daughter cells, give rise to daughter cells one of which is homozygous for one of these alleles, the other being homozygous for the other allele. Phenotypically differing cell-lines may result. Studies of somatic crossing-over, somatic assortment, and cell fusion make up somatic-cell genetics, a modern asexual genetic technique that allows a wide range of *in vitro* manipulation of higher cells, including human cells as well as those of other organisms.

somatic mutation Mutation occurring in a somatic cell. If the mutated cell continues to divide, the individual will develop a patch of tissue with a genotype different from the cells of the rest of the body.

somatotropin *See* growth hormone.

sombric horizon Subsurface soil horizon of well drained, mineral, tropical and subtropical soils into which humus has leached downward. Base saturation is less than 50%. It is a diagnostic horizon in the USDA Soil Taxonomy system.

somite In vertebrate embryos, one of a series of blocks of mesoderm (germ layer composed of cells which have moved from the surface to the interior) flanking the notochord on the dorsal side in two longitudinal strips.

Somniosus microcephalus (Greenland shark) *See* Squalidae

song Complex pattern of sound produced by means of specialized organs. Such organs are used by many animals in communication.

song thrush (*Turdus philomelos*) *See Turdus*.

Sonneratia (family Sonneratiaceae) Genus of mangrove trees with breathing roots, in which the flowers have many stamens, inserted on the calyx tube, and the ovary is superior. The flowers are sour-smelling, nocturnal, and bat-pollinated. The fruit is a leathery berry seated on the persistent calyx. There are five species, occurring from E. Africa and Madagascar to the W. Pacific islands.

sooty grunter (*Hephaestus fuliginosus*) *See* Theraponidae.

sooty mould Dark, soot-like, fungal growth which appears on plants infested with sap-sucking insects such as aphids or scale insects; these insects produce a sugary fluid ('honeydew'), and the sooty-mould fungi grow on this. Sooty moulds may belong to various genera, but *Cladosporium* species are the commonest.

Sophora (family Leguminosae, subfamily Papilionoideae, tribe Sophoreae) Genus of trees and shrubs, and a few perennial herbs, in which the leaves are alternate, usually pinnate with numerous leaflets, and with stipules. The flowers are held in terminal racemes or leafy panicles. They are irregular, with the lateral petals enclosed by the upright petal when in bud, and white, yellow, or blue-violet in colour. The calyx is composed of five fused sepals with short teeth. The five petals are held with the two lower ones partly fused, the two lateral and one upright standard. There are 10 free stamens. There is a single carpel, and the ovary is superior, with numerous ovules. The fruit is a fleshy or woody pod, which is often indehiscent. The seeds have thick cotyledons. The timber of the tree species is especially hard and strong, e.g. *S. tetraptera* (four-winged sophora) of New Zealand and Chile is used for bearings in machines, as well as for ornamental purposes. Dye is obtained from *S. japonica*. There are 50 species, found in all tropical and temperate regions, particularly in Asia and America.

Sophora tetraptera (four-winged sophora) *See Sophora*.

Sophora japonica *See Sophora*.

soralium Mass or cluster of soredia.

Sorbus (family Rosaceae) Genus of trees and shrubs with simple or pinnate leaves, and no thorns. They are similar to *Pyrus* (pear) in flower structure, with five petals, and many stamens, but the cartilaginous carpel walls are not completely united to the apex in the fruit, and the flowers are borne in compound corymbs, not simple, umbel-like inflorescences. The genus includes *S. aucuparia* (rowan or mountain ash), *S. aria* (white beam), and *S. torminalis* (wild service tree). There are about 100 species, occurring in northern temperate regions, some taxonomically very critical.

Sorbus aria (white beam) *See Sorbus*.

Sorbus aucuparia (rowan, mountain ash) *See Sorbus*.

Sorbus torminalis (wild service tree) *See Sorbus*.

Sordariaceae (order Sphaeriales) Family of fungi in which the asci are persistent, and the ascospores typically dark-coloured when mature. The perithecia are not grouped within a stroma. There are many genera. Most are saprotrophic, and found on dung, wood, or soil.

Sordes pilosus Discovered in 1971, one of the first pterosaurs known to have been covered in thick fur: the name means 'hairy filth'. The indication is that this reptile and its close relatives were homoiotherms. It was found in Upper Jurassic sediments of Chimkent, Soviet Kazakhstan, and was a small, toothed pterosaur with a long tail.

soredium Microscopic structure formed by certain lichens as a means of vegetative propagation: it consists of a few fungal hyphae among which are enmeshed a few cells of the phycobiont. To the naked eye, soredia in masses appear as a granular or fine powder.

sori *See* sorus.

Soricidae (shrews; order Insectivora, suborder Lipotyphla, superfamily Soricoidea) Family of small mammals with short, dense fur, small eyes, ears which are usually visible externally, and long, mobile muzzles equipped with many sensory receptors. The upper molar teeth have a characteristic W-shaped pattern, and the first upper incisor is long and curved. There is no zygomatic arch. The Soricidae are distributed throughout the world except for Australasia and most of S. America. There are 21 genera, with some 250 species.

Soricoidea (order Insectivora, suborder Lipotyphla) Superfamily comprising all the members of the Lipotyphla with the exception of the hedgehogs and moonrat. The superfamily is divided into the families Soricidae (shrews), Talpidae (moles), Solenodontidae (solenodon), Tenrecidae (tenrec and otter shrew), and Chrysochloridae (golden mole); but the last three of these families are sometimes classed as superfamilies in their own right.

sorocarp In certain slime moulds, a fruiting structure consisting of an unenclosed mass of spores borne at the tip of a stalk.

sorrels *See* Polygonaceae.

sorus (pl. sori) In plants, a fruiting structure consisting of a mass of spores or sporangia.

Sotalia (tucuxi) *See* Stenidae.

souma Wasting disease of cattle and other animals, caused by the protozoon *Trypanosoma congolense*. The pathogen is transmitted by the tsetse fly (*Glossina*).

source region (for air masses) Extensive areas of essentially uniform surface conditions over land or water, typically of large-scale air subsidence and lateral divergence, where air masses develop their initial properties.

soursop (*Annona muricata*) *See Annona*.

Sousa (hump-backed dolphin, white dolphin) *See* Stenidae.

South American lungfish (*Lepidosiren paradoxa*) *See* Lepidosirenidae.

Southampton series classificatory programme *See* association analysis; information analysis; and inverse analysis.

south Brazilian floral region Part of Good's (1974) Neotropical kingdom, which contains a large flora with about 400 endemic genera; a high proportion of its several thousand species is also endemic.

Many important economic and ornamental plants derive from this region.

southerly buster Regional wind in S. and SE Australia, characterized by a rapid shift in direction from north-west to south in the rear of a cold front. Such winds are especially prevalent between October and March. The change to a southerly wind can bring a great increase in wind-speed accompanied by a rapid and marked fall in temperature. Such conditions are akin to line squalls, and related to the S. American pamperos.

southern beech See *Nothofagus*.

southern hawker (*Aeshna cyanea*) *See* Aeshnidae.

'southern lights' *See* aurora.

Southern Ocean *See* Antarctic Ocean.

southern roughy (*Trachichthys australis*) *See* Trachichthyidae.

southern sassafras *See Atherosperma moschatum*.

southern sea carp (*Dactylosargus arctidens*) *See* Aplodactylidae.

southern smelt *See* Retropinnidae.

southern whiting *See* Sillaginidae.

south temperate oceanic-island floral region Part of Good's (1974) Antarctic kingdom which contains a very small flora scattered amongst the islands of the oceans surrounding Antarctica. There are only two endemic genera, one of which is disjunct between several islands. Despite the great distance separating the islands, and their varying latitudes, there is a notable floristic constancy. A characteristic vegetation is tussocky grassland, dominated by vicarious species of *Poa*.

south-west Australian floral region Part of Good's (1974) Australian kingdom, which is a very rich floral region with a high degree of endemism, in many respects rivalling that of the Cape region of S. Africa. The same families are prominent in both floras and they have many growth forms in common.

spadefish *See* Ephippidae.

spadefoot toad *See Pelobates fuscus*.

spadix Spike of flowers on a swollen axis.

Spalacidae (mole rats; order Rodentia, suborder Myomorpha) Family of fairly large (up to 28 cm long) mole-like rodents (or subfamily of Muridae) which have soft, dense fur that can lie forward or backward; round heads; short forelimbs but longer, powerful, hind limbs; no externally visible tail; and vestigial eyes and ears. They live mainly below ground but often come to the surface at night. They are distributed throughout the E. Mediterranean region and in SE Europe. There are three species in a single genus, *Spalax*.

spangled drongo (*Dicrurus hottentottus*) *See Dicrurus*.

spangle gall *See* gall wasp.

Spanish chestnut (*Castanea sativa*) *See Castanea*.

Spanish fly (*Lytta vesicatoria*) *See* Meloidae.

Spanish grass (*Stipa tenacissima*) *See Stipa*.

Spanish lynx (*Lynx pardina*) *See Lynx*.

Sparassidae (order Araneae, suborder Araneomorphae) Family of spiders in which the legs are held sideways, like those of crabs. These large and often flattened spiders run and catch prey, and are largely tropical and nocturnal. *Heteropoda venatoria* (huntsman spider) is often imported to Britain in banana crates.

Sparassis (subclass Holobasidiomycetidae, family Sparassidaceae) Genus of fungi in which the hymenium is borne on the under-side of one or more flattened, petal-like lobes. *S. crispa* ('brain fungus', 'cauliflower fungus') forms fruit bodies that are large (20–50 cm across), pale yellow or buff, and densely branched with numerous flattened, crinkled lobes. It is found at the base of conifer trees or tree stumps.

Sparidae (sea bream, porgy; class Osteichthyes, subclass Actinopterygii, order Perciformes) Large family of marine, perch-like, silvery fish, which have a deep, compressed and fully scaled body; a continuous, single, dorsal fin; and forked tail-fin. Many of the sparid fish are rated highly by both amateur and professional fishermen. Well-known species include *Pagellus bogaraveo* (red sea bream), 50 cm, of the E. Atlantic, and *Acanthopagrus latus* (Japanese silver bream), 45 cm, of the Indo-Pacific area. There are about 100 species, distributed worldwide in warm to temperate waters.

sparrowhawks *See Accipiter*.

sparrows 1 *See* Emberizidae; *Passer*; and Ploceidae. 2 (rock sparrows) *See Petronia*. 3 (American sparrows) *See Aimophila*.

Spatangoida (heart-urchins; class Echinoidea) Order of irregular echinoids, which have a compact apical system and a plastron in which the labrum is followed by a pair of large plates. Most spatangoids have narrow bands of densely ciliated spines (fascioles) represented by areas of very small tubercles on denuded tests. The Spatangoida first appeared in the lowermost Cretaceous.

spathe In monocotyledons, a large bract subtending an inflorescence.

Spathebothridea (phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms which possess repeated genitals. The scolex may be present. They inhabit two hosts during their development.

Spathodea (tulip trees; family Bignoniaceae) Genus of evergreen trees which have pinnate leaves and large, red flowers in racemes. The pod splits into two parts. The seeds are winged. They are planted for their attractive flowers. There are two species, occurring in tropical Africa.

spathose iron *See* siderite.

spatter cone Volcanic cone built from tephra blown out as clots of relatively fluid lava.

spatulate Having an end that is broad and flattened, like a spatula.

spawn 1 (mycol.) Fungal mycelium. Among mushroom growers, a block of manure or other suitable substrate bearing a growth of mycelium of *Agaricus bisporus*, used to start a new culture of mushrooms. 2 Mass of eggs laid in water by crustaceans, fish, amphibians, or other aquatic animals.

spearfish *See* Istiophoridae.

spear-headed grasshoppers *See* Pyrgomorphidae.

special adaptation *See* general adaptation.

special creation The belief that the origin of life and the diversity of life result from acts of God whereby each species was created separately. Evolution is implicitly rejected as the explanation of these phenomena.

specialization Degree of adaptation of an organism to its environment. A high degree of specialization suggests both a narrow habitat or niche and significant interspecific competition.

speciation The separation of populations of plants and animals, originally able to interbreed, into independent evolutionary units which can interbreed no longer owing to accumulated genetic differences. In cladistics, the origin of one or more new species occurs inferentially by cladogenesis.

species (sing. and pl.) Literally, a group of organisms that resemble one another closely: the term derives from the Latin *speculare*, 'to look'. In taxonomy, it is applied to one or more groups (populations) of individuals that can interbreed within the group but that cannot exchange genes with other groups (populations)—an interbreeding group of biological organisms that is isolated reproductively from all other organisms (*see* biospecies). A species can be made up of groups in which members do not actually exchange genes with members of other groups (though in principle they could do so), as for example at the two extremes of a continuous geographical range. However, if some gene flow occurs along a continuum, the formation of another species is unlikely to occur. Where barriers to gene flow arise (e.g. physical barriers, such as sea, or areas of unfavourable habitat) this reproductive isolation may lead either by local selection or by random genetic drift to the formation of morphologically distinct forms termed 'races' or 'subspecies'. These could interbreed with other races of the same species if they were introduced to one another. Once this potential is lost, through some further evolutionary divergence, the races may be recognized as species, although this concept is not a rigid one. Most species cannot interbreed with others; a few can, but produce infertile offspring; a smaller number may actually produce fertile offspring. The term cannot be applied precisely to organisms whose breeding behaviour is unknown. *See* morphospecies; and palaeospecies.

species–area curve *See* minimal area.

species group (superspecies) Complex of related species that exist allopatrically (in different geographical areas from one another). They are grouped together because of their morphological similarities, and this grouping can often be supported by experimental crosses in which only certain pairs of species will produce hybrids.

species longevity The persistence of species for long periods of time, characterizing for example Gastropoda and Bivalvia.

specific humidity The mass of vapour in a kilogram of air. *See also* humidity; and mixing ratio.

spectacle *See* Serpentes.

spectacled caiman *See Caiman crocodilus*.

specular iron *See* haematite.

specularite *See* haematite.

speculum In birds, a well-defined patch of coloured feathers, often iridescent, found on the secondaries or secondary coverts of many Anatidae, particularly *Anas* species.

speedwell *See Veronica*.

speleothem *See* dripstone.

Speothos venaticus (bush dog) *See* Canidae.

sperm *See* spermatazoon.

spermaceti Highly vascular tissue, filled with a mixture of fatty esters (oils) which solidify at about 32 °C, produced by Physeteridae (sperm whales) and stored in the upper part of an enlarged snout. A full-grown sperm whale may carry one tonne of spermaceti. The function of spermaceti is not known with certainty, but as its density changes as it liquefies and solidifies it may help provide neutral buoyancy to the animal, and it may contribute to the production of the sounds by which the animal echo-locates.

spermatheca Container or sac connected to the genital tract of a female insect, which acts as a sperm store. It is of ectodermal origin and is lined with cuticle. The spermatheca is often lined with glandular cells which are thought to supply nourishment for the sperm.

spermatid One of four haploid cells formed during the second reduction-division of meiosis in male animals. Without further division they undergo cytoplasmic changes and condensation of the nucleus to give rise to spermatozoa. This process is called spermiogenesis.

spermatiophore (mycol.) Hypha that bears a spermatium.

spermatium (mycol.) In certain types of fungi, a microscopic, single-celled, male reproductive cell.

spermatocyte Diploid cell that undergoes meiosis and forms four spermatids. A primary spermatocyte undergoes the first meiotic division to form two secondary spermatocytes. These then divide (the second meiotic division) to produce two spermatids each (i.e. a total of four haploid cells).

spermatogenesis The formation of sperm (spermatozoa) from a diploid male germ cell. It includes both male meiosis and spermiogenesis.

spermatogonia Mitotically active cells in the gonads of male animals, which give rise to primary spermatocytes.

spermatophore 1 Gelatinous cone of jelly secreted by the cloacal glands of male urodeles (class Amphibia) with a sperm cap on top. It is deposited by the male during the courtship ritual and picked up by the cloacal lips of the female, thus enabling internal fertilization. 2 Packet of sperm, produced in a wide range of insect groups, which may be deposited on the ground or transferred directly to the female. The spermatophore has a gelatinous protein capsule produced by the male accessory glands.

Spermatophyta Division of the plant kingdom that comprises the seed-bearing plants. They arose in the Devonian from pteridophyte forebears, probably of a heterosporous character. These early seed plants belonged to the Gymnospermae. The other subdivision of the Spermatophyta, the Angiospermae, is not certainly represented in the fossil record until the early Cretaceous.

spermatazoon (sperm) In animals, the male gamete. It is a small, motile cell, flagellated in most species.

spermiogenesis The formation of sperm from the spermatids (spermatozoa) produced during two reduction-divisions of spermatocytes.

sperm whale (*Physeter catodon*) *See* Physeteridae.

spessartine Mineral, specific gravity 4.18, hardness 6.5–7.5, and with the chemical composition $Mn_3Al_2(SiO_4)_3$, named after the Spessart Mountains, Bavaria, W. Germany. It belongs to the garnet group of minerals and thus is widely distributed in metamorphic and igneous rocks, and in beach and river sands. It is distinguished by its hardness and crystal form. It is dark red to orange-yellow or brown, and has a greasy to vitreous lustre. It crystallizes in the cubic system. The crystals are commonly rhombododecahedra.

Sphacelariales (class Phaeophyceae) Order of brown algae in which growth occurs from a large, dense, brown, apical, meristematic cell. This cell divides transversely, and then the daughter cells divide longitudinally. The thallus is generally filamentous and branched. *Sphacelaria cirrhosa* is a common British species; it forms small, dense tufts, 0.5–2.5 cm tall, on other seaweeds. It is found throughout the year on the lower shore and below low-water mark.

Sphaeriales (class Pyrenomycetes) Order of fungi in which the ascocarps typically are spherical, hemispherical, or flask-shaped perithecia. There are many families, including saprotrophs and plant parasites.

Sphaeriidae (class Insecta, order Coleoptera) Family of tiny beetles, less than 1 mm long, in which the body is very rounded and shining. The wings have reduced venation, and fringes of long hairs. The antennae are clubbed. Tarsi are three-segmented, the claws unequal. Sphaeriidae are found in wet areas. Larvae are aquatic, oval, and yellowish. There is only one British species, *Sphaerius acaroides*, which lives in fens. There are 11 species worldwide.

Sphaeritidae (class Insecta, order Coleoptera) Family of small, convex, shiny beetles, in which the terminal abdominal segment is exposed. The antennae have three-segmented clubs. They are distinguishable from the closely related Histeridae by the absence of elbowed antennae. Adults are associated with fungi, but little is known of their life history. There are three species.

sphaerocyst Spherical cell, clusters of which are present in the flesh of the fruit bodies in fungi of the Russulaceae.

Sphaerophoraceae (order Caliciales) Family of lichens in which the thallus is fruticose, branched, and solid. The ascocarps are embedded within the thallus at the edges or tips. Spores are brown and aseptate or one-septate. There are several genera, found chiefly in cool moist regions of the southern hemisphere.

Sphaeropsidales (class Coelomycetes) Order of imperfect, microscopic fungi which produce their conidia in pycnidia or in stromata. There are four families, and many genera. They are saprotrophic or parasitic on plants.

Sphaerotilus Genus of Gram-negative bacteria which are not assigned to any taxonomic family. Cells are rod-shaped, occurring mostly in chains which are enclosed by thin sheaths; single cells also occur, and these are motile by means of a tuft of flagella. *Sphaerotilus* species are aerobic, and chemo-organotrophic. There is one species, *S. natans*, found in sewage treatment plants and in slow-moving freshwater streams polluted with sewage and other effluents. It occurs attached to plants, stones, etc., forming a major component of the slimy growth known as 'sewage fungus'.

Sphagnopsida *See Sphagnum*.

Sphagnum (subclass Sphagnidae, class Musci) Genus of mosses which differ in several respects from other mosses; they are sometimes classified in a separate class (Sphagnopsida). The plants are characteristically branched with branches in fascicles of 2–8. The leaves are nerveless and are composed of two main types of cell: narrow, green, living cells; and inflated, colourless, dead cells. The latter cells readily become filled with water, allowing the plant to hold many times its own weight of water. The capsules of *Sphagnum* are also unique; they are roughly spherical with no peristome. When the capsule is ripe, the wall shrinks on drying and the pressure inside builds up until the lid is blown off and the spores are ejected. There are many species, often difficult to distinguish, found, often abundantly, in various wet, acidic habitats: bogs, marshes, pools, moors, wet woodland, damp grassland, etc. The genus is distributed worldwide.

sphalerite (black jack, zinc blende) Mineral, specific gravity 3.9–4.1, hardness 3.5–4.0, chemical composition is ZnS, whose name is derived from the Greek word *sphaleros*, meaning 'deceptive',

referring to the fact that it does not resemble other common metal sulphides. It is the most common ore mineral for zinc metal, and is frequently associated with galena in hydrothermal veins, and also in limestones where it occurs by replacement. It commonly occurs with pyrite, pyrrhotite, and magnetite. It is very variable in colour and is often very difficult to recognize, being easily mistaken for other minerals. It dissolves in concentrated nitric acid with the separation of sulphur. Its colour is variable, but is commonly yellow, brown, or black, and the crystals can be transparent to translucent. It has a brown to bright yellow or white streak, and a resinous to near-metallic lustre. It has a conchoidal fracture. It crystallizes in the cubic system. The crystals are tetrahedral or rhombododecahedral, with curved faces, but they can also be granular, fibrous, or botryoidal.

Sphecidae (digger wasps, sand wasps; order Hymenoptera, suborder Apocrita) Large family of solitary hunting wasps that are very closely related to the bees and, together with them, form the superfamily Sphecoidea. They differ from the bees in that the body hairs are unbranched and the hind basitarsis has the same width as do the following segments (rather than being wider than them). Sphecids hunt a wide range of insect prey. A few catch spiders, others Collembola. At the level of species, sphecids are prey-specific. There is a tendency for primitive sphecids to hunt primitive insect prey, e.g. cockroaches or crickets, while the more advanced species hunt more highly evolved insect prey, e.g. flies and beetles. There are nine subfamilies, which some recent authors have suggested should be accorded family status. There are 7600 species, with a cosmopolitan distribution, the important genera being *Ammophila*, *Astata*, *Bembix*, *Cerceris*, *Crabro*, *Philanthis*, and *Sphex*. *See also* hunting wasp.

Sphecodes *See* Halictidae.

Sphecoidea (bees, digger wasps, sand wasps; order Hymenoptera, suborder Apocrita) Superfamily containing two families of hunting wasps, Ampulicidae and Sphecidae, and 11 families of bees, Andrenidae, Anthophoridae, Apidae, Colletidae, Ctenoplectridae, Fideliidae, Hallictidae, Megachilidae, Oxaeidae, Melittidae, and Stenotritidae. The Sphecoidea differ from all other Hymenoptera in the structure of the pronotum, the lateral lobes of which do not reach as far as the tegulae, or to below it. The posterior pronotal lobe is rounded and limited to the spiracular cover.

Sphecotheres (Old World orioles) *See* Oriolidae.

sphene (titanite) Mineral, specific gravity 3.4–3.6, hardness 5.0–5.5, chemical composition $CaTiSiO_5$, whose name comes from Greek and means 'wedge'. It is widely distributed as an accessory mineral in coarse-grained igneous rocks, e.g. syenites, diorites, and granodiorites. It also occurs in schists, gneisses, and metamorphosed limestones. It is distinguished by its greenish-yellow colour and wedge-shaped crystals. It is brown and greenish-yellow, or sometimes grey to nearly black, and has an adamantine to greasy lustre. It has a conchoidal fracture. It crystallizes in the monoclinic system. The crystals are normally flattened and wedge-shaped.

Spheniscidae (penguins; order Sphenisciformes) Family of medium- to large-sized, marine birds, most of which have black upper-parts and white under-parts. Their feathers are very small and dense, and some birds have crests above the eye. Their bills are short and stout to long and pointed, their legs short and set well back, with webbed toes. Their wings are modified into paddles which do not fold, and they have short tails. They are flightless and swim well under water, coming to land to breed. They walk upright on land, or slide on their bellies. They feed on fish and other marine animals, and nest in burrows or on the ground. There are six genera, with 18 species, found on the coasts of Antarctica, S. America, S. Africa, Australia, New Zealand, and sub-antarctic islands.

Sphenisciformes (penguins; class Aves) Order that comprises the single family Spheniscidae.

Sphenodontidae (tuatara; class Reptilia, order Rhynchocephalia) Family of primitive, lizard-like reptiles up to 60 cm long, which have a horny, dorsal crest. A pineal eye is present. The front upper teeth are beak-like. There is no copulatory organ. They are carnivorous, feeding on invertebrates and small vertebrates. There is one species, *Sphenodon punctatus* (tuatara), confined to a few islands off New Zealand.

Sphenopsida Subdivision of the Pteridophyta, represented today by one genus only, *Equisetum*. Sphenopsids flourished in the Carboniferous coal swamps and one of the fossil types of this period, *Calamites*, included tree-like forms that grew to 30 m.

spheridia Minute, club-shaped, calcareous bodies (modified spines) on short stalks, which are commonly situated in pits in the peristomal region of ambulacra in echinoids. Their function is uncertain.

spheroidal weathering The development of concentric shells of normally chemically weathered material in the outer zone of a joint-bounded mass of rock. The spheroidal or onion-skin appearance results from enhanced weathering at joint intersections together with the expansion resulting from chemical change.

spheroidosis Disease of insects caused by viruses of the entomopoxvirus group. The disease may affect larval and other stages of insects of the Coleoptera, Diptera, Lepidoptera, and Orthoptera.

Sphex *See* Sphecidae.

Sphingidae (hawk moths, sphinx moths; order Lepidoptera) Family of medium-sized to very large moths that are usually fast fliers. The forewings are elongate, narrow, and obliquely angled terminally. The proboscis is often very long and is used to suck nectar. Some species have tympanal organs ('ears') on the palps. The larvae bear a horn at the rear. There are about 8000 species, several of which have an intercontinental distribution, although the family is mainly tropical.

sphingolipid One of a group of lipids containing sphingosine or its derivatives, found predominantly in the membranes of nerve cells.

sphingomyelin Generic term for a group of phosphorus-containing sphingolipids found principally in the nervous tissue, but also in the blood. Chemically they are regarded as phosphoryl choline derivatives of a ceramide.

sphingosine An 18-carbon, unsaturated alcohol amine, the parent compound of sphingolipids.

sphinx moths *See* Sphingidae.

Sphyraena barracuda (giant barracuda) *See* Sphyraenidae.

Sphyraenidae (barracuda; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have a very elongate, slender body, a large mouth with strong teeth, and two widely separated dorsal fins. Barracudas have the reputation of being aggressive and dangerous fish. Although most species rarely exceed 60 cm in length, *Sphyraena barracuda* (giant barracuda) grows to 1.7 m. There are about 18 species, distributed widely in tropical to subtropical waters.

Sphyrnidae (hammerhead shark; class Chondrichthyes, subclass Elasmobranchii, order Lamniformes) Small family of marine, occasionally brackish-water sharks characterized by the sideways expansion of the head with the eyes and nostrils located almost at the tip of the lateral expansions. These peculiar sharks are found principally in tropical coastal regions and tend to be large—*Sphyrna zygaena*, for example, which grows to 7 m. There are about nine species.

Spicara smaris (picarel) *See* Emmelichthyidae.

spicate In spikes.

spicule A small needle or spine.

spider beetle *See* Ptinidae.

spider crabs 1 *See* Majidae. 2 (giant spider crab) *See Macrocheira kaempferi*. 3 (spiny spider crab) *See Maja squinado*.

spiderhunters *See* Nectariniidae.

spider-hunting wasps *See* hunting wasp; and Pompilidae.

spider monkey (*Ateles*) *See* Cebidae.

spider plant (*Tradescantia*) *See* Commelinaceae.

spiders 1 *See* Arachnida; Araneae; funnel-web spiders; Liphistidae; Mimetidae; *Phoneutria fera*; Sparassidae; and trapdoor spiders. 2 (black widow spider) *See Latrodectus mactans*. 3 (brown recluse spider) *See Loxosceles reclusa*. 4 (cobweb spiders) *See* Theridiidae. 5 (comb-footed spiders) *See* Theridiidae. 6 (crab spiders) *See* Thomisidae. 7 (house spider) *See Tegenaria gigantea*. 8 (hunting spiders) *See* Lycosidae. 9 (jumping spiders) *See* Salticidae. 10 (money spiders) *See* Linyphiidae. 11 (nursery-web spiders) *See* Pisauridae. 12 (orb-web spiders) *See* Araneidae; and *Araneus diadematus*. 13 (purse-web spiders) *See* Atypidae; and *Atypus affinis*. 14 (sheet-web spiders) *See* Agelenidae. 15 (spitting spiders) *See* Scytodidae. 16 *See* tarantula; and Theraphosidae. 17 (water spider) *See Argyroneta aquatica*. 18 (wolf spiders) *See* Lycosidae.

spike Raceme with the flowers all sessile.

spikefish *See* Triacanthodidae.

spikelet *See* Gramineae.

spiky dory (*Neocythus rhomboidalis*) *See* Oreosomatidae.

spilling breaker ('surf wave') Wave that advances into shallowing water at the same speed as the velocity of the water at its crest. Consequently it does not break, but gradually diminishes in height until it moves up the beach as swash. Typically it occurs when a fairly steep wave moves over a gently sloping, sandy beach.

spillway General term for a channel cut by water associated with glacial activity, and normally including three varieties: (a) that cut by water escaping from a glacially impounded lake (*see* overflow channel); (b) that cut by meltwater released from a decaying glacier (*see* meltwater channel); and (c) that cut by a stream deflected by an advancing glacier. Impressive examples were developed in central Europe (the Urstromtäler of N. Germany) when the Scandinavian ice sheet diverted streams flowing north from the southern highlands.

Spinachia (spinach) *See* Chenopodiaceae.

spinal column In vertebrates, the backbone, consisting of a jointed chain of small bones or cartilages (vertebrae) running longitudinally near the dorsal surface and joining the head. In Cyclostomata (lampreys and hagfish) the vertebrae are in two halves lying to either side of the persistent notochord; but in other vertebrates they form a hollow tube enclosing the spinal cord, more or less replacing the notochord.

spinal cord In vertebrates, a tube containing nerve cells and bundles of nerve fibres, many of which connect to the brain, enclosed within the spinal column.

spindle The set of microtubular fibres that appear to move the chromosomes of eukaryotes during cell division. The spindle is formed only at mitosis or meiosis, appearing at metaphase and first arranging the chromosomes at its equator. Movement apart of chromatids then occurs during anaphase, probably as a result of contraction of the fibres that run from the centromere (spindle attachment) to the spindle pole, and from pole to pole.

spindle attachment (centromere) The region of attachment on a chromosome that links it to the spindle at mitosis or meiosis. Its position determines its shape at anaphase (a rod, or J, or V). In a few species the centromeric properties are distributed along the entire length of the chromosome; such species are said to be 'polycentromic', (possessing a diffuse centromere).

spindle tree (*Euonymus europaeus*) *See* Celastraceae; and *Euonymus*.

spinefoot *See* Siganidae.

spinel Mineral, specific gravity 3.5–4.1, hardness 7.5–8.0, and with the chemical composition $MgAl_2O_4$. It occurs as an accessory mineral in igneous rocks, especially gabbro, and also in contact metamorphic rocks with limestones, and, because of its hardness, also in alluvial deposits. It is distinguished by its octahedral form and its hardness. It is variable in colour, but commonly red, or otherwise blue, green, brown, black, or colourless; it has a white streak, and a vitreous lustre. It crystallizes in the cubic system. The crystals are commonly octahedra, and also massive. Flawless crystals are used as gemstones.

spinetails *See Synallaxis*.

Spinifex (family Gramineae) Genus of coastal grasses which are dioecious. The spikelets are sessile, break into small pieces when ripe, and are distributed by the wind. The male spikelets are two-flowered and arranged in spikes composed of a cluster of 4–6, with long bracts. The female spikelets are very numerous and held in a large, dense head, each with a spine-like rachis which is longer than the spikelet and the bract. The plants are perennial, with thick rhizomes and stolon which can spread several metres over the sand. The plant is rough or hairy, with silvery leaves, and a ligule of hairs. The genus is used to stabilize coastal sand-dunes. There are three species, found in E. and SE Asia, Australia, and the Pacific region, two of the species being indigenous to Australia.

spinner *See* Ephemeroptera.

spinneret One of the specialized silk-handling devices found in spiders. In general there are four pairs, two pairs on the tenth abdominal segment and two pairs on the eleventh, although few spiders retain the maximum complement in the adult stage. The anterior median pair is usually lost, but sometimes a remnant may remain in the form of a median cone (colulus) whose function is unclear. In some cases the anterior median pair fuse during embryonic development to form an oval plate covered with thousands of tiny spigots (the cribellum). Some spiders retain only two pairs of spinnerets, losing both the anterior media and posterior lateral pairs. Spinnerets are movable, sclerotized tubes composed of several segments; they vary in size, and are mostly conical in web-spinning species. The silk glands produce a protein (fibroin) as a liquid which is emitted through tiny spigots on the ends and ventral sides of the spinnerets. Polymerization of the liquid silk is not an oxidative or evaporative process, but relies on tension.

spinney A wood that consists, or consisted formerly, of thorns (*Crataegus*).

Spinosauridae Carnosaur family of the Cretaceous of N. America and N. Africa. In *Spinosaurus* the neural spines were elongated to give a pelycosaur-like sail, presumably an adaptation to tropical environments.

spiny ant-eater (*Tachyglossus*) *See* Tachyglossidae.

spiny dormouse (*Platacanthomys*) *See* Platacanthomyidae.

spiny eel *See* Mastacembelidae; and Notacanthidae.

spiny finray The hard, pointed, unsegmented, unpaired, and unbranched finray found in varying number in the dorsal, anal, and pelvic fins of many bony fish (e.g. perch and scorpionfish).

spiny lobsters 1 *See* Palinuridae. 2 (giant spiny lobster) *See Jassus heugeli*.

spiny mouse *See* Heteromyidae.

spiny rat *See* Echimyidae.

spiny spider crab *See Maja squinado*.

spiny-tailed lizards *See Uromastyx*.

spiracle 1 Essentially a vestigial gill slit located between the mandibular and hyoid arches in adult sharks, rays, and some primitive bony fish, and visible as an opening behind the eye. 2 One of the ports on the body of an insect at which the tracheae open to the outside. Spiracles are found on the thoracic and abdominal segments, and usually have some mechanism to close them.

Spiraculata (class Blastoidea) Order of echinoderms which are characterized by the possession of hidden hydrospire slits. They range in age from Silurian to Permian.

spiral wrack (twisted wrack) Common name for the brown seaweed *Fucus spiralis*. The thallus differs from that of bladder wrack (*F. vesiculosus*) in lacking air bladders, and from that of serrated wrack (*F. serratus*) in that the margins are not serrated; the branches are usually somewhat twisted spirally. It is found attached to rocks rather higher on the shore than other *Fucus* species.

spire Young timber tree the lowest branch of which is at a considerable height.

Spiriferida (class Articulata) Order of Brachiopoda, whose members have spiral brachidia, punctate or impunctate biconvex shells, and a large body cavity. They first appeared in the Middle Ordovician, and are last known from the Lower Jurassic. There are four suborders, 11 superfamilies, and 31 families.

Spirillaceae Family of Gram-negative bacteria in which the cells are rigid, and spiral in shape. They are motile with one or more flagella at one or both ends of each cell, swimming with a corkscrew-like motion. They are aerobic, micro-aerophilic, or anaerobic chemo-organotrophs. There are two genera, *Spirillum* and *Campylobacter*. Some species are found free-living in aquatic environments, others are parasitic or pathogenic in certain animals.

Spirillum (family Spirillaceae) Genus of rigid, spirally-shaped bacteria in which the cells usually have a tuft of flagella at each end. They are aerobic or micro-aerophilic. There are many species, found in freshwater or marine habitats. An exceptional species, *S. minor*, is parasitic in rats and can cause rat-bite fever in humans.

Spirochaeta (family Spirochaetaceae, order Spirochaetales) Genus of free-living, spirally-shaped bacteria which are obligately or facultatively

anaerobic. There are several species, found in sulphide-rich aquatic habitats, including sewage and polluted waters.

Spirochaetales Order of bacteria in which the cells are slender, spiral in shape, and flexible, and 0.003–0.5 mm long. They are motile with rotating and flexing movements; their motility is due to axial fibrils, which resemble flagella but are sandwiched between the peptidoglycan and outer membrane layers of the cell wall. Species are aerobic, anaerobic, or facultatively anaerobic. They are chemo-organotrophs. There is one family, with five genera, including some important pathogens (e.g. *Treponema pallidum*), found in a wide range of habitats. Also, spirochaetes are an essential part of the symbiosis between termites and flagellate protozoans.

spirochaete Bacterium belonging to the order Spirochaetales.

Spirogyra (family Zygnemataceae, order Zygnematales) Genus of green, freshwater algae, in which the thallus consists of unbranched filaments. It is capable of a spiral gliding motility when illuminated. The chloroplast forms a spiral, ribbon-like band which extends the length of the cell. Conjugation occurs by the formation of a tube connecting two cells; the contents of one cell pass through the tube and fuse with those of the other cell. *Spirogyra* is very common in standing fresh water, especially in spring.

Spiroplasma (family Spiroplasmataceae, order Mycoplasmatales) Genus of bacteria in which the cells are somewhat variable in shape, but all can form helical filaments; the cells lack cell walls. They are motile by an unknown mechanism; there are no flagella. They are chemo-organotrophic, and can grow in the presence or absence of air. They are parasitic in plants and arthropods, and can cause disease, e.g. stubborn disease of citrus trees.

Spirotrichia (class Ciliatea) Subclass of protozoa in which the system of cilia in the oral region is well developed and conspicuous. Rows of oral cilia are arranged spirally, winding down toward the cytostome. Body cilia are usually sparse. There are six orders, and many genera. They occupy a wide range of habitats.

Spirulina (order Nostocales) Genus of filamentous cyanobacteria in which the filaments are characteristically coiled. They are capable of gliding motility. They are found in freshwater and marine habitats, mostly in warmer regions; and are also found in hot springs. *Spirulina* is collected and used as food in the region of Lake Chad, Africa.

spissatus From the Latin *spissatus* meaning 'thickened', a species of cirrus cloud which has sufficient thickness to appear grey even when the cloud is between the Sun and the observer. *See also* cloud classification.

spit Elongated accumulation of sand or gravel projecting from the shore into a water body. Longshore drift of material is usually responsible for the development of a spit.

spitting spiders *See* Scytodidae.

spittlebug *See* Cercopidae.

Spizaetus (hawk eagles; family Accipitridae) Genus of small to fairly large eagles, which appear slender, with short, rounded wings, and long tails. Some species have a long, pointed crest. They have brown upper-parts, and many have barred under-parts. They inhabit forests, feed on birds and mammals, and nest in trees. There are 10 species found in Africa, Asia, Indonesia, and C. and S. America.

Splachnum (order Funariales) Genus of mosses which are characteristically found growing on or associated with animal dung. The leaves are soft, lanceolate to obovate, with a thin nerve. The capsule is held erect on a long seta. *Splachnum* is a small genus found mainly in the northern hemisphere. *S. ampullaceum* and *S. sphaericum* occur in Britain. *S. ampullaceum* forms dense, light-green tufts on cattle dung. The capsules, borne on red setae, are often numerous and are characteristic in shape, resembling miniature Greek amphorae. They are found mainly in the upland regions of the west and north of Britain, particularly on wet heaths and moors, and in bogs.

splanchnocoel In vertebrate embryos, one of a pair of temporary coelomic cavities located on either side of the body below the gut.

spleenworts *See Asplenium*.

splenic fever *See* anthrax.

spodic horizon Subsurface soil horizon in which organic matter together with aluminium and often iron compounds have accumulated amorphously. It is a diagnostic horizon in the USDA Soil Taxonomy.

Spodosols Order of the USDA Soil Taxonomy describing soils in which subsurface horizons contain amorphous materials comprising organic matter and compounds of aluminium and often iron that have accumulated illuvially. Such soils form in acid material, mainly coarse in texture, in humid cool to temperate climates.

spodumene Mineral, specific gravity 3.0–3.2, hardness 6.5–7.0, and with the chemical composition $LiAlSi_2O_6$. It typically occurs in lithium-rich granites and pegmatites, associated with lepidolite, tourmaline, and beryl. It is distinguished by two well-marked cleavages. It is usually greyish-white, often with a greenish or yellowish-green tinge; occasionally it is violet. It is transparent to translucent, and has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are prismatic, and often striated, etched, and corroded. It can also be massive and columnar. The green variety (hiddenite) and the lilac variety (kunzite) are used as gemstones, otherwise it is an ore of lithium.

Spondias (family Anacardiaceae) Genus of trees, most of which have pinnate leaves. The fruit is a slightly angled drupe with a big round or angled stone, edible in several species (hog plum). There are 10 species occurring in Indo-Malaysia and tropical America.

spondylium Curved platform for muscle attachment in the beak region of some brachiopods.

sponges *See* Porifera.

Spongiaria *See* Porifera.

spongin In some Porifera, a structure of interconnecting coarse collagen fibres which forms the skeleton of the animal.

Spongiomorphida (order Hydroida) Extinct order of stromatoporoid-like Cnidaria in which stellate, vertical tubules develop from the radial grouping of six vertical pillars around a seventh. They occur only in Triassic and Jurassic rocks, particularly in the warm waters of the Tethys, in the earlier period.

spontaneous mutation In genetics, a naturally occurring mutation, as opposed to one artificially induced by chemicals or irradiation. Usually such mutations are due to errors in the normal functioning of cellular enzymes.

spookfish (*Dolichopteryx longipes*) *See* Opisthoproctidae.

spoonbills *See* Ciconiiformes; *Platalea*; and Threskiornithidae.

sporangiolum (mycol.) Sporangium within which there is only a single spore or small number of spores.

sporangiophore Specialized hypha which bears a sporangium.

sporangiospore Spore formed within a sporangium.

sporangium (mycol.) Sac-like structure within which spores are formed; spores are liberated on rupture of the sporangium wall.

spore 1 (mycol.) Microscopic structure which functions in reproduction and dispersal. A spore does not contain an embryo and thus is distinct from a seed. Many different types of spore are produced by fungi. 2 (bacteriol.) Differentiated cell which may function as a propagule or as a resistant structure that allows the organism to survive adverse environmental conditions.

spore mother cell Diploid plant cell that gives rise to four haploid spores during meiosis.

spore print The pattern of spores obtained when the cap of a fungal fruit body is placed, gills or pores down, on a sheet of paper and left for a period of time.

Sporobolomycetaceae (class Blastomycetes) Family of imperfect yeasts characterized by the production of ballistospores. There are four genera. These yeasts are saprotrophic, and found on plant material.

sporocarp Structure the primary function of which is the production of spores; a fruit body.

sporodochium Cushion-shaped mass of fungal tissue densely covered with conidiophores.

sporogenesis The production of spores in plants. In mosses and liverworts the process occurs in a sporogonium; in fungi it occurs in a sporophore; in other spore-forming plants it occurs in a sporangium.

sporogony Process of reproduction in which a zygote undergoes multiple fission.

sporophore Structure upon which spores are borne directly.

sporophyll Leaf in the Pteridophyta that bears sporangia. The term is most often applied to the small, scale-like leaves in the cones of *Lycopodium* and *Selaginella*, which bear sporangia on their upper sides.

sporophyte The spore-producing diploid generation in the life cycle of plants. In higher plants such as angiosperms and gymnosperms, the sporophyte is the dominant generation, forming the conspicuous plant. In lower plants such as mosses, liverworts, ferns, and fungi, the gametophyte is the dominant and conspicuous generation.

Sporozoa (phylum Protozoa) Subphylum of protozoa in which the life cycle includes a spore-forming or cyst-forming stage. Asexual reproduction occurs by multiple fission. All members are parasitic, parasitizing hosts throughout the animal kingdom. Some species can cause important diseases.

sporozoite In Sporozoa, a spore produced by fission of a zygote.

sport Sudden deviation from type; a mutation.

sporulation The process of spore formation.

spotted barramundi (*Scleropages leichardti*) *See* Osteoglossidae.

spotted butterfish (*Scatophagus argus*) *See* Scatophagidae.

spotted creeper (*Salpornis spilonotus*) *See* Salpornithidae.

spotted fever Any of a number of human diseases caused by rickettsias and characterized by a skin rash.

spotted flycatcher (*Muscicapa striata*) *See Muscicapa*.

spotted javelin (*Pomadasys hasta*) *See* Pomadasyidae.

spotted scat (*Scatophagus argus*) *See* Scatophagidae.

spraing Disease of potatoes, which may be caused by either of two different viruses, or by adverse growth conditions. Tubers from infected plants show characteristic crescent-shaped brown marks in the flesh when cut. The viruses are transmitted by eelworms or by soil fungi.

spray Wood trimmings, sold in faggots for kindling. *See also* bavins.

spring *See* springwood.

springtail Member of the order Collembola, which possesses specialized leaping mechanisms (the furcula and retinaculum).

spring tide Tide of greater range than the mean range; the water level rises and falls to the greatest

extent from the mean tide level. Spring tides occur about every two weeks when the Moon is full or new. Tides are at their maximum when the Moon and the Sun are in the same plane as the Earth.

springwood (spring) 1 High forest that has grown from shoots from tree stumps. 2 The ground growth or shoots of new coppice that emerge from the stools of a felled coppice. *See also* tree-ring.

spruce *See Picea*.

spurdog (*Squalus acanthias*) *See* Squalidae.

spurge olive (*Cneorum*) *See* Cneoraceae.

spurges *See Euphorbia*.

spurred valerian (*Centranthus*) *See* Valerianaceae.

spur-thighed tortoise *See Testudo graeca*.

spur-throated grasshoppers *See* Acrididae.

squalene Open-chain terpene found in shark-liver oil, which acts as an intermediate in the biosynthesis of cholesterol.

Squalidae (dogfish; class Chondrichthyes, subclass Elasmobranchii, order Squaliformes) Fairly large family of marine sharks which have two dorsal fins, each often preceded by a solid spine. The anal fin is lacking. Some species, e.g. *Etmopterus spinax* (Atlantic velvet belly), 90 cm, are relatively small, while others, e.g. *Somniosus microcephalus* (Greenland shark), may reach a length of about 6.4 m. Like other members of the family, *Squalus acanthias* (spurdog), 1.2 m, is a live-bearing species which often travels in large schools and is sometimes caught by trawlers. There are at least 61 species, distributed worldwide.

Squaliformes Order of sharks characterized by the presence of two dorsal fins of about equal size and the absence of an anal fin. The dorsal fins may be preceded by a spine. The order includes the families Pristiophoridae, Squalidae, and Squatinidae.

squall Short-lived condition with strong winds, which rise by at least 16 knots (30 km/hr). It may include thunder and heavy precipitation. *See also* line squalls.

Squalodontoidea (shark-toothed whales; order Cetacea, suborder Odontoceti) Extinct superfamily of toothed whales, comprising the family Squalodontidae and its immediate ancestors. The squalodonts were about the size of modern porpoises, which they probably resembled closely in appearance and behaviour. The teeth in the posterior part of the beak were triangular in shape and resembled those of sharks. The beak was often elongated. The skull was modified to the form characteristic of modern odentocetes and the blowhole was positioned above and behind the eyes. The superfamily appeared in the late Oligocene, and was distributed throughout the world during the early Miocene, but by the middle Miocene it was being replaced by more advanced porpoises and by the Pliocene the last squalodont was extinct.

Squalus acanthias (spurdog) *See* Squalidae.

squamae In Diptera (true flies), flap-like appendages at the base of the wings which are often attached to the thorax close to the wing base, and which sometimes conceal the halteres. In some Brachycera and Cyclorrapha they are obvious as waxy, white flaps.

Squamata (lizards, snakes; class Reptilia) Highly successful order, which includes 95% of all living reptiles. The lizards and snakes are each given ordinal status in some classifications. The earliest lizards had appeared by the Triassic and the snakes, which might be regarded as 'legless' lizards, diverged from the ancestral line in the Cretaceous. The skull has lost the lower temporal arch, allowing mobility of the quadrate and increased gape. The tongue is notched or forked. Body scales are generally small and overlapping. Limblessness is common. They are divided into two suborders (or orders), Sauria (Lacertilia) and Serpentes (Ophidia).

Squamiferidae (order Isopoda, suborder Oniscidea) Family of terrestrial isopods which are covered in scales (their name being derived from the Latin *squama*, scale, and *fere*, to bear), and up to 6 mm long. Most species in the family lack eyes and have no tracheal system.

squamosal The bone forming the posterior part of the side of the skull, which in Mammalia articulates with the lower jaw.

squamulose Bearing or consisting of small scales (squamules).

squaretail *See* Tetragonuridae.

squarrose With projecting scales or rigid leaves. Of a moss, with leaves in which the upper part is curved back, at 90° or more to the lower part.

squashbug *See* Coreidae.

Squatina squatina (monkfish) *See* Squatinidae.

Squatinidae (angel shark, monkfish; class Chondrichthyes, subclass Elasmobranchii, order Squaliformes) Small family of marine sharks which have a rather flattened body, and large pectoral fins. Angel sharks tend to live in fairly shallow seas, feeding on bottom-living animals. The brown or greenish, mottled *Squatina squatina* (monkfish), 1.8 m, of the E. Atlantic, is one of the more common species. There are about 11 species, distributed in the Atlantic and Pacific.

squids *See* Teuthoidea.

Squilla mantis (mantis shrimp; superorder Hoplocarida, order Stomatopoda) Species of mantis shrimps in which the female carries her large egg mass on her body, to which it is glued by a special adhesive secreted from glands opening from the last three thoracic segments. The zoeal larval stage may last for 12 weeks.

squirrelfish (*Holocentrus ascencionis*) *See* Holocentridae.

squirrels *See* Anomaluridae; and Sciuridae.

^{87}Sr *See* radiometric dating.

s-RNA Soluble RNA: transfer-RNAs that are relatively small molecules and are more soluble in acid than other RNAs.

S-shaped growth curve (sigmoid growth curve) Pattern of growth in which, in a new environment, the population density of an organism increases slowly initially, in a positive acceleration phase; then increases rapidly approaching an exponential growth rate as in the J-shaped curve; but then declines in a negative acceleration phase until at zero growth rate the population stabilizes. This decline reflects increasing environmental resistance which becomes proportionately more important at higher population densities. This type of population growth is termed 'density-dependent' since growth rate depends on the numbers present in the population. The point of stabilization, or zero growth rate, is termed the 'saturation value' (symbolized by *K*) or 'carrying capacity' of the environment for that organism. *K* represents the upper asymptote of the sigmoidal or S-shaped curve produced when changing population numbers are plotted over time. It is usually summarized mathematically by the logistic equation. *See* density-dependence; *compare* J-shaped growth curve.

stability Atmospheric condition in which air that is forced to rise tends to return to its pre-existing position in the absence of the uplifting force. If the adiabatic lapse rate of uplifted air is greater than the environmental lapse rate, then the vertically displaced air will become colder than the surrounding air and as its density increases it will tend to sink back. *See also* instability.

stabilizing selection *See* maintenance evolution.

Stachybotrys (class Hyphomycetes) Form-genus of fungi in which the vegetative stage is a septate mycelium; chains of dark-coloured conidia are produced from phialids. Some species produce a toxin which can lead to poisoning if ingested by humans or other animals.

stack Pillar or block of rock, with near-vertical sides, standing adjacent to a present or former sea cliff. Typically it is isolated from the main cliff by wave erosion concentrated along steeply inclined joints or faults.

Stackhousia (family Stackhousiaceae) Genus of annual or perennial herbs with simple, alternate leaves, which often show xerophytic features (e.g. succulent leaves). The regular, bisexual flowers are held in clusters, or racemes, or are solitary, and are composed of a united, five-lobed calyx and a partly fused corolla with the narrow or broad petals united only in the centre. The fruit is a schizocarp which splits into one-seeded segments along the locule partitions. The large seeds contain a fleshy endosperm. The plants are usually components of open grass or sedge communities, often in sand-dunes or on soils of low fertility. There are 25 species, all endemic to Australia and New Zealand, except for one which is found in Indonesia.

Stackhousiaceae Family of xerophytic, annual or perennial herbs which have a branched rhizome system. The leaves are simple and alternate, with stipules, and are often succulent or leathery. The flowers are regular and bisexual, and are held in racemes or clusters spread along the stem. There are five fused sepals forming a lobed calyx tube, with five petals, either free or partly fused, and five stamens which usually alternate in length. The ovary is superior, with 2–5 uni-ovular locules. The styles are partially fused. The fruit is a schizocarp which splits along the locule partitions into single-seeded segments. The seeds contain a large embryo and fleshy endosperm. There are three genera, with 27 species, restricted in distribution to Malaysia, Indonesia, Australia, and New Zealand.

stag beetle *See* Lucanidae.

stage (geol.) Fourth-order unit in chronostratigraphy, the equivalent of age in terms of geological time units. It refers to the body of rock accumulated during one age unit.

stag-horn sculpin (*Gymnocanthus tricuspis*) *See* Cottidae.

stag's horn fungus Common name for the abnormal, antler-like, fruit bodies of *Lentinus lepideus* found on timber in damp, dark places such as coal mines.

stalactite Elongated body of dripstone descending from the roof of a cave in a karst environment. It is produced by calcite precipitation as excess carbon dioxide diffuses from water droplets entering a cave environment.

stalagmite Pinnacle of dripstone rising from the floor of a cave in a karst environment. It is produced by the precipitation of calcite as excess carbon dioxide diffuses when water droplets strike the floor.

stalk bodies *See* cristae.

stalk-eyed flies *See* Diopsidae.

stamen The male organ of a flower, comprising a stalk (the filament) and the anther which is commonly two-lobed, the lobes united by the connective.

staminode Rudimentary stamen which produces no pollen but which may function as a nectary or petal.

stand (ecol.) 1 Standing growth of plants, e.g. trees. 2 Term used in vegetation classification to describe a distinctive plant association that may be recognized elsewhere. The composition may vary slightly but the recognition of stands enables comparisons between different vegetation communities to be made. Sometimes the suffix '-etum' is added to the stem of the generic name of the dominant species.

standard 1 Tree that is allowed to grow to its full height. 2 Single-trunked tree that is large enough to be converted to sawn timber.

standing crop *See* biomass.

standing wave Type of wave in which the surface of the water oscillates vertically between fixed points without any forward progression. The crest at one moment in time becomes the trough at the

next and so on. Standing waves are caused by the meeting of two similar wave groups that are travelling in opposing directions.

stand of the tide Period at high or low water during a tidal cycle when there is little or no change in the height of the tide. The water level is almost stationary and the tidal currents fall away to zero velocity before reversing.

stannite (tin pyrite) Comparatively rare mineral, specific gravity 4.3–4.5, hardness 3.0–4.0, chemical composition Cu_2FeSnS_4. It occurs in hydrothermal tin ore deposits and in association with cassiterite, chalcopyrite, and wolframite. It is also found in stanniferous sphalerite-galena ores, and associated with sphalerite, pyrrhotite, and galena. It is distinguished by its grey colour with an olive-green tinge. It is steel-grey with an olive-green tinge on fresh surfaces, which become yellowish on exposure, and it has a black streak, and a metallic lustre. It crystallizes in the tetragonal system. The rare crystals are cubes or tetrahedra, but normally the grains are irregular or massive.

stapes In Mammalia, the inner auditory ossicle of the ear, stirrup-shaped because it is pierced by an artery. It is derived from the hyomandibular bone in fish, which connects the cranium and the upper jaw, and the columella auris of other tetrapods.

Staphyleaceae Family of trees and shrubs in which the leaves are sometimes opposite, trifoliate or pinnate, and the leaflets serrate, with stipules. The flowers are hermaphrodite or unisexual, with five sepals and petals, five stamens, a disc, and the ovary superior; and usually trilocular. There are six genera, with 60 species, occurring in tropical Asia and America, and in the northern temperate zone.

Staphylinidae (rove beetles; class Insecta, order Coleoptera) Family of beetles, most of which are elongate, 1–28 mm long, and generally shining, black, black and red, or metallic. The elytra are short, leaving over half of the abdomen exposed. Some species are highly sculptured or pubescent. The head and mandibles are large, the antennae filiform. The abdomen is highly flexible, and is often raised in a threat gesture. Many rove beetles are strong fliers. Larvae resemble wingless adults, with the hind part of the body generally paler, without toughened plates. Adults and larvae are found in damp places, decaying matter, and dung, where they prey on other insects. Many are associated with ants' nests, some producing sweet substances highly attractive to ants. *Staphylinus olens* (Devil's coach horse), is Britain's largest staphylinid. Some tropical species produce chemicals that blister the skin and cause eye irritation. There are 27 000 species, making this the second largest beetle family.

Staphylinus olens (Devil's coach horse) *See* Staphylinidae.

Staphylococcus (family Micrococcaceae) Genus of bacteria in which the spherical, Gram-positive cells occur singly, in pairs, and in irregular clusters. They are non-motile. They are chemo-organotrophic, and capable of growth in the presence or absence of air. They are found mainly in or on the bodies of mammals. Many can be pathogenic, causing a variety of conditions including boils, abscesses, 'food poisoning', etc.

star apple (*Chrysophyllum cainito*) *See Chrysophyllum*.

starch Homopolysaccharide, comprised of D-glucose molecules, which is the major storage carbohydrate of plants. It occurs in two forms, the straight-chained amylase and the branched-chain amylopectin.

starfish *See* Asteriadina; Asteroidea; Brisingina; Cribellina; Diplozonina; Eugnathina; Forcupulatida; Granulosina; Leptognathina; Notomyotina; Paxillosida; and Platyasterida.

stargazer *See* Uranoscopidae.

starlings 1 *See* Sturnidae. 2 (glossy starling) *See Aplonis*.

starry pufferfish (*Arothron stellatus*) *See* Tetraodontidae.

starry ray (*Raja radiata*) *See* Rajidae.

stasigenesis Situation in which an evolutionary lineage persists through time without splitting or otherwise changing. So-called 'living fossils' provide examples of stasigenesis.

stasipatric speciation Rapid speciation that may occur among small breeding populations that are not completely isolated genetically or spatially. The term is more or less synonymous with 'parapatric speciation'.

stasis (evol.) Period of little or no evolutionary change; the 'equilibrium' that alternates with 'punctuations' (rectangular speciation) in the theory of punctuated equilibrium.

stationary front Condition in which the frontal boundary between cold and warm air is stationary.

statismospore (mycol.) Spore that is not violently discharged at maturity.

statistical method In modern usage, a method for analysing data based on probability theory. A statistical method permits the calculation of a value based on observations about some problem that may be tested for significance by comparison with the values that might be expected to arise by chance. Two main categories of statistical methods have been developed: classical or parametric tests, and the more recent non-parametric or distribution-free tests. Parametric statistical methods may be applied only to data on an interval scale, and typically they make assumptions about the background population from which the sample is taken, most often that it is normally distributed. Where data are in nominal or ordinal form, or where assumptions about the distribution of data on which a parametric test is based cannot be justified, then non-parametric (distribution-free) methods can be used. In general, parametric tests are more rigorous than non-parametric tests. Formerly, and more colloquially, 'statistical methods' embraced any form of data gathering and analysis. *Compare* numerical method.

statoblast In Bryozoa, a mass of cells containing stored food enclosed in a chitinous envelope, which can withstand desiccation and freezing and which may remain dormant for prolonged periods.

statocyst In certain aquatic invertebrates, a vesicle containing mineral grains that stimulate sensory cells as they move in response to the movement of the animal.

staurolite Mineral, specific gravity 3.7–3.8, hardness 7, and with the chemical composition $(Fe,Mg)_2(Al,Fe)_9Si_4O_{20}(O,OH)_2$, whose name is derived from the Greek and means 'cross', referring to its typical twinned form. It occurs in medium-grade schists and gneisses, often in association with garnet, kyanite, and mica. It is distinguished by its cross-shaped crystal form. Normally it is brown, but it can be reddish-brown or brown-black. It has a vitreous to resinous lustre. It crystallizes in the monoclinic system. The crystal occurrence is usually prismatic, but can also occur massive.

Stauromedusida (subclass Scyphomedusae) Order of Cnidaria in which the adults are solitary, attached, somewhat polypoid, medusae, of conical or vase-shaped body. They are inhabitants of cold seas and coastal waters.

steam fog *See* arctic sea smoke.

steatite *See* talc.

Steatornis caripensis (oilbird) *See* Steatornithidae.

Steatornithidae (oilbird; order Caprimulgiformes) Monotypic family comprising *Steatornis caripensis* which is a chestnut-coloured bird, marked with white spots. It has long, pointed wings, a long tail, and short legs. It has a short, hooked bill, a wide gape, and rictal bristles. It is nocturnal and inhabits caves, using echo-location to fly about in the dark. It feeds on fruit, and nests colonially on cave ledges. It is found in S. America.

Stegodontidae (order Proboscidea, suborder Mammutidae) Extinct family of mammals whose evolution paralleled that of the true elephants. The low-crowned molar teeth had cusps arranged in transverse ridges, with traces of cement, and the tooth succession typical of elephants was present, although the stegodonts still retained permanent premolars. The family appeared during the Miocene in Asia, and later invaded Africa; they died out during the Pleistocene, having reached as far east as Timor in the late Pleistocene.

Stegosauridae Suborder of quadripedal, ornithischian dinosaurs, mainly Jurassic in age, characterized by a double row of plates and spines along the back and tail.

stellate Star-shaped; radiating in arrangement.

stem In a vascular plant, the part of the plant that bears buds, leaves, and flowers. It forms the central axis of the plant and often provides mechanical support. Most commonly it is above ground, but it may lie below ground, and is then termed a 'rhizome'.

stem cell Mitotically active cell that serves to replenish those that die during the life of a metazoan organism (somatic stem cell) or that produces a continuing supply of gametes (germinal stem cell).

stem flies *See* Chloropidae.

Stemonitales (subclass Stemonitomycetidae) Order of slime moulds with the characteristics of the subclass. The best-known genus is *Stemonitis*, in which the fruiting bodies are brown, elongated, narrow sporangia borne on black, glossy stalks. There are many species, found on dead wood, humus, etc. The order comprises one family and at least 13 genera.

Stemonitomycetidae (class Myxomycetes) Subclass of slime moulds in which spores are borne internally, enclosed within a peridium which is often short-lived. The fruiting body may or may not be stalked. Species are found on rotting wood, plant litter, dung, soil, etc.

stem reptiles *See* Captorhinomorpha.

Stenidae (order Cetacea, suborder Odontoceti) Family of small, porpoise-like mammals in which the snout is long and merges into the forehead, the dorsal fin is hooked, and the tail is slightly notched at the midline. Members of the Stenidae attain lengths of about 2 m. There are four species, in three genera. *Steno* (rough-toothed dolphin) is distributed throughout the tropical and warm-temperate oceans. *Sotalia* (the tucuxi) occurs around the coast of S. America and in the rivers Amazon and Orinoco. *Sousa* (the white or hump-backed dolphin) occurs in coastal waters around Africa and S. Asia. Many authorities include the three genera in the Delphinidae.

Steno (rough-toothed dolphin) *See* Stenidae.

steno- In ecology, a prefix used with adjectives that describe environmental factors, denoting a limited tolerance by an organism of those factors. *Compare* eury-.

stenoecious Applied to an organism that can live only in a restricted range of habitats. *See* steno-.

stenohalic *See* stenohaline.

stenohaline (stenohalic) Very sensitive to changes in salinity; unable to tolerate a wide range of osmotic pressures. *See* steno-.

Stenolpelmatidae (Jerusalem crickets, king crickets, sand crickets, stone crickets; order Orthoptera, suborder Ensifera) Family of large, wingless insects, most species of which live in rotting logs or under stones, or burrow in sand or loose soil. They are most common in the tropics. One Indian genus is blind, and always lives below ground. The antennae are usually longer than the body.

stenopaic Applied to an eye in which the pupil is narrow and slit-like.

stenophagic Having a highly specialized diet. *See* steno-.

stenothermal *See* stenothermous.

stenothermous (stenothermal) Unable to tolerate a wide temperature range. *See* steno-.

Stenotritidae (order Hymenoptera, suborder Apocrita) Family of large to very large, hairy, ground-nesting bees: they are entirely restricted to Australia. Formerly regarded as a subfamily of the Colletidae, stenotritids are unique among bees in having the simple eyes (ocelli) situated low on the front of the head, nearer to the antennal sockets than to the posterior margin of the vertex. The nest of only one species, *Stenotritus pubescens*, has been described. The cells were unlined and the provisions consisted entirely of nectar and *Eucalyptus* pollen.

Stephanoberycidae (pricklefish; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of deep-sea fish which live at depths of more than 1500 m. They are small (15 cm) and have large eyes and a large mouth. Although the fins have no spines, the rough-edged scales give the fish a prickly appearance. There are three species.

stephanokont Cell that has a ring of flagella or cilia near one end.

Stephen Island wren (*Xenicus lyalli*) *See* Xenicidae.

steppe meadow *See* meadow-steppe.

Stercorariidae (skuas; order Charadriiformes) Family of medium to large, dark brown sea birds, some colour phases of which have white underparts. They have long, pointed wings, long to medium-length tails, and *Stercorarius* species have elongated central tail feathers. Their bills are medium length, strong, and hooked; their legs are short, with webbed feet. They are pelagic, occurring near coasts and breeding on islands or on inland tundra. They feed on mammals, insects, eggs, fish, and carrion, often obtained by chasing and robbing other birds. They nest on the ground. There are two genera, with six or seven species, found worldwide, breeding in northern areas of Europe, Asia, and N. America, and southern S. America and sub-antarctic islands.

Sterculiaceae Family of trees, shrubs, climbers, and herbs which have stellate hairs or scales. The leaves are simple or palmately compound, with stipules, and the petiole is often long and kneed. The flowers are regular, small, and pentamerous, with a stamenal tube ovary which has 2–5 locules. The fruit is commonly dry and dehiscent. There are about 60 genera, with 700 species, occurring mainly in the tropics and subtropics.

Stereaceae (order Aphyllophorales) Family of fungi in which the fruit bodies are flattened, and usually appressed (*see* appressorium) or resupinate. The spores are smooth and colourless. There are 10 genera, found mostly on wood. Some are important parasites of plants.

Stereocaulaceae (order Lecanorales) Family of lichens in which pseudopodetia are formed; the pseudopodetia are solid and may bear scales ('phyllocladia'). Apothecia are borne at the tips of the pseudopodetia. Spores are multiseptate or muriform. There are four genera, found only on acidic substrates, either on rocks or on the ground, chiefly in cool, humid regions or in mountainous areas of warmer regions.

stereographic projection A two-dimensional graphic representation of a three-dimensional solid object, in which the angular relationships of lines and planes of the object are drawn in terms of their relationship to the great circle formed by the intersection of the equatorial plane with the surface of an imaginary sphere in which the object is contained. Stereographic projections are used widely in structural geology and crystallography.

stereotaxis *See* thigmotaxis.

Stereum (family Stereaceae) Genus of fungi which includes both saprotrophic and parasitic species. Some species are common on decaying timber in woodland. *S. purpureum* is responsible for the disease 'silver leaf' in plum trees; this species is sometimes called *Chondrostereum purpureum* and classified in the family Corticiaceae.

sterile 1 Of an organism, unable to produce reproductive structures, i.e. unable to reproduce. 2 Of land, unable to support the growth of plants, especially cultivated crops. 3 Of an environment, object, or substance, completely free of all living organisms, including all micro-organisms of any type or form.

sterilization 1 The removal of the ability to reproduce (which may be achieved by surgery upon the gonads or their ducts, or by hormonal application). 2 The process of killing or removing all living micro-organisms from a sample (e.g. by autoclaving).

sterlet (*Acipenser ruthenus*) *See* Acipenseridae.

Sterna (terns; family Laridae) Genus of small to large sea birds, most of which have grey upperparts, white under-parts, and a black cap. Some have short crests. They have long, slender to stout, pointed bills, and short legs with webbed feet. They have long, pointed wings, and short tails, some being deeply forked with long tail streamers. They inhabit coastal and inland waters, feed on fish caught by diving, and nest on the ground. There are 32 species, most migratory, found worldwide.

sternite Ventral region of a segment of the body of an insect, if the region is composed of sclerotized cuticle. (If not, the region is termed a 'sternum'.)

Sternoptychidae (hatchetfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of marine fish which have a deep, short, and very compressed body, the outline of the belly resembling the blade of a hatchet. The mouth is large and directed upward. Many photophores are present on the flanks of *Argyropelecus lychnus* (silvery hatchetfish), 6 cm. There are about 27 species, distributed worldwide at depths of 100–4000 m.

Sternotherus odoratus (stinkpot, common musk turtle; order Chelonia (Testudines), suborder Cryptodira, family Kinosternidae) Bottom-living turtle whose name is due to the unpleasant odour from its cloacal glands. It grows up to 14 cm long. The plastron is reduced and unhinged. It feeds on amphibians, fish, carrion, and aquatic invertebrates, and is seldom seen on land. It occurs in ponds and sluggish streams in the USA.

sternum 1 In tetrapods, the bone at the mid-ventral line of the thorax to which most of the ribs are attached at their ventral ends. The sternum is attached anteriorly to the pectoral girdle. 2 In arthropods, a ventral cuticle on each segment that forms a thickened plate. *See* sternite.

steroid One of a group of derivatives of the fused, reduced ring compound perhydrocyclopentanophenanthrene. As a group steroids have a wide range of physiological functions: they include bile acids, adrenocorticoid and sex hormones, and sterols such as cholesterol.

stibnite *See* antimonite.

Stichaeidae (prickleback; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine fish which have long, slender bodies, and long dorsal fins extending to the tail end of the body and composed entirely of spiny rays. Pricklebacks (e.g. *Anoplarchus purpurescens*, high cockscomb, 20 cm, of Canada) tend to live in the intertidal zone, where the females guard their eggs by curling the body around the egg mass until hatching occurs. There are about 57 species, occurring in the N. Pacific and N. Atlantic.

stick insects *See* Phasmatidae; and Phasmatodea.

stickleback *See* Gasterosteidae.

Sticta (family Lobariaceae) Genus of lichens in which the thallus is foliose; the lower surface is downy and is perforated by cyphellae. The phycobiont may be a green alga or a cyanobacterium. Some species have a strong, characteristically fishy smell. The apothecia are lecanorine. Spores are colourless or brown, with 1–3 septa. In Britain, *Sticta* species are found chiefly on mossy trees or rocks in moist western districts.

stifftails *See Oxyura*.

Stigeoclonium (family Chaetophoraceae, order Ulotrichales) Genus of filamentous green algae in which the filaments are branched, and the chloroplast forms a band around the middle of the cell (as in *Ulothrix*). They are common in still or running water. They are tolerant of organic pollution and are sometimes used as an indicator of heavily polluted water.

stigma 1 *See* carpel. 2 *See* Proctotrupidae.

Stigonema (order Stigonematales) Genus of filamentous, branched cyanobacteria in which the filaments may consist of a single row or many adjacent rows of cells enclosed within a gelatinous sheath. Typically it forms furry patches on damp rocks.

Stigonematales (division Cyanobacteria) Order of filamentous cyanobacteria in which the filaments show true branching. Species are structurally the most complex of all the cyanobacteria; some may show differentiation into erect and prostrate filaments. Heterocysts are present. They are found for example on damp rocks.

stiletto flies *See* Therevidae.

stilt root Root that arises from the lower bole and that runs obliquely to the ground, as in mangroves and a few palms.

sting The ovipositor of aculeate Hymenoptera, which has lost its egg-laying function and serves as a means of injecting venom into the prey of hunting wasps, and is used as a means of defence by bees. The sting of honeybees (*Apis* species) and some social wasps is barbed and remains in the skin of the victim after the wasp or bee has become detached. In honeybees the muscular venom sac of detached stings continues to pump venom, and it also emits an alarm pheromone which alerts other workers, which may be recruited to join the attack.

stingless bees *See* Apidae.

stingray 1 *See* Dasyatidae. 2 (river stingray) *See* Potamotrygonidae.

stink gland In most Heteroptera (plant bugs and water bugs), glands that produce fluids believed to be distasteful to potential predators. In the immature stages (nymphs) these are situated between the abdominal tergites, but in adults they are in the metathorax.

stinkhorn Common name for the fungal fruit body in some members of the Phallales. The common stinkhorn, *Phallus impudicus*, has a white, spongy, hollow stem 10–20 cm tall. The cap is initially covered with an olive-brown slime containing the spores, but the slime is eventually removed by flies. This fungus has a strong, fetid odour detectable from a distance of several metres. It is common in woods, gardens, etc. in summer and autumn. The dog stinkhorn, *Mutinus caninus*, is similar but smells less strongly.

stinking smut *See* bunt.

stinkpot *See Sternotherus odoratus*.

stints *See Calidris*.

Stipa (needle grasses; family Gramineae, subfamily Pooideae, tribe Stipeae) Genus of tough, sharp, mostly perennial grasses, whose spikelets are single flowers and held in panicles with conspicuous awns. The spikelets are needle-like. The leaves are tough and narrow, sometimes with a small row of hairs forming a ligule. There are 300 species found in temperate and tropical regions, where the grasses are common in arid plains and form the characteristic genus of the steppes throughout the world. *S. pennata* (feather grass) is commonly found in the Russian steppes. About 50 of the species are endemic to Australia, and all of them have a two-lobed lemma. Several species have narcotic properties and are known as 'sleepy grasses', e.g. *S. inebrians*. *S. tenacissima* (esparto grass or Spanish grass), native to Spain and N. Africa, is used to make ropes, wickerwork, and high-quality paper.

Stipa pennata (feather grass) *See Stipa*.

Stipa tenacissima (esparto grass, Spanish grass) *See Stipa*.

stipe 1 (mycol.) The stalk or stem of a fungal fruit body. 2 *See* Graptolithina.

stipitate Having a stipe or stalk.

Stipiturus (emu wrens) *See* Maluridae.

stipule Leafy or linear appendage, found, usually in pairs, at or near the base of the petiole of a leaf.

Stipules are often variously patent (i.e. spreading), but may be adpressed to petiole or twig. Occasionally they are amplexicaul (i.e. surrounding and clasping the twig). These uncommon positions are valuable aids to plant identification.

Stizostedion vitreum (walleye) *See* Percidae.

stoat (*Mustela*) *See* Mustelidae.

stock 1 Igneous intrusion, approximately circular in plan, that has steep contacts with the country rocks and a surface area of 20 km^2 or less. 2 *See* graft.

stoggal Tree that has been cut short or that has been broken down by the wind, and that is therefore not suitable for use as timber.

stolon 1 (bot.) Stem that grows horizontally, a runner. 2 (zool.) In colonial invertebrates, the stalk-like structure by which individuals are attached to the substrate. *See*, e.g., Ctenostomata.

Stolonifera 1 (subclass Octocorallia) Order of corals with polyps arising from a basal stolon, which creeps over solid objects. Skeletal spicules may fuse into tubes and platforms. Stolonifera are found in shallow tropical and temperate waters. They first appeared in the Cretaceous. 2 (class Gymnolaemata, order Ctenostomata) Suborder of bryozoans, in which the stolon is slender and of creeping habit. Zooids grow by lateral budding from the stolon and are usually paired. The suborder appeared in the Ordovician and survives to the present day.

Stolonoidea (class Graptolithina) Extinct order of sessile or encrusting graptolites, composed largely of stolothecae, possibly with autothecae. The stolons divide very irregularly, in some forming interlacing groups, in others giving off single branches. They are poorly known from only one genus in the Lower Ordovician.

stolotheca One of the three types of graptolite thecae, which encloses the main stolon and the earliest parts of the daughter stolotheca, autotheca, and bitheca.

stoma (pl. stomata) Small opening, many of which are found hn the epidermal layers of plants, allowing access for carbon dioxide and egress for water. Stomata are surrounded by guard cells which control the pore size.

stomach Anterior region of the gut, enlarged and usually with muscular walls that churn food and with cells in the lining that secrete digestive acids.

stomata *See* stoma.

Stomatopoda (mantis shrimps; class Crustacea, subclass Malacostraca, superorder Hoplocarida) Order of crustaceans, 5–36 cm long, many of which are brightly coloured, with striped or mottled patterns. The body is flattened dorsoventrally and there is a shield-like carapace. The entire dorsal surface is armed with ridges and spines, and the abdomen is broad and segmented. The head has stalked, compound eyes with a median nauplius eye; large, triramous, first antennae; and smaller third antennae. The thoracic appendages are uniramous and subchelate, with the second pair modified for raptorial prey capture. As the common name implies, the large second thoracic appendages are equipped with a movable process armed with spines and barbs. Prey is caught or speared by a rapid extension of this process. Many species inhabit bottom burrows or crevices in coral or rock, and defend their burrows using the telson as a shield. They may leave their burrows to stalk prey (e.g. crabs) and swim using their pleopods, steering by means of their large antennal scales and uropods. Apart from isopods, mantis shrimps are the only malacostracans that have abdominal gills. Many species exhibit parental care of their eggs. They comprise the only order of their superorder, with approximately 300 species. Most are tropical but some live in temperate waters.

Stomias boa (scaly dragonfish) *See* Stomiatidae.

Stomiatidae (scaly dragonfish; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of deep-sea fish, which have long, tapering bodies covered with loosely attached scales, and a very large mouth with fang-like teeth suggestive of voraciously predatory behaviour. The dorsal and anal fins are set close to the small tail-fin. Usually dark in colour, *Stomias boa* (scaly dragonfish), 40 cm, is thought to live at depths of more than 1000 m. There are about nine species, distributed worldwide.

Stomochorda (phylum Hemichordata) Subphylum of bilateral coelomate animals with a body divisible into three segments: protosoma, mesosoma, and metasoma. The mouth is situated ventrally between the protosoma and mesosoma. The diverticulum of the dorsal part of the pharynx extends forward to form the stomochord. The posterior part of the pharynx opens to the exterior through branchial pores. There is a notoneural nervous system. Stomochorda occur first in Lower Ordovician rocks.

stomodaeum (stomodeum) In many invertebrates and vertebrate embryos, a mouth-like modification of the anterior end of the gut formed by an indentation of the ectoderm opening into the enteron.

stomodeum *See* stomodaeum.

stone canal In Echinodermata, a canal with walls strengthened by calcareous matter connecting the madreporite with the water-vascular system.

stone crab (*Menippe mercenaria*) *See* Xanthidae.

stone crickets *See* Stenolpelmatidae.

stonecrops (*Sedum*) *See* Crassulaceae.

stone-curlew *See* Burhinidae.

stone fish *See* Synanceiidae.

stone stripe *See* patterned ground.

stonesucker (*Gyrinocheilus aymonieri*) *See* Gyrinocheilidae.

stonewort Common name for the brittle, calcified plants of the Charophyta; *Chara* and *Nitella* are the commonest British genera. The plant consists of a

'stem' or axis which bears whorls of branches at intervals (nodes) along its length. The axis is attached at its base to the substratum by means of branched rhizoids.

stony corals *See* Madreporaria.

stool 1 Tree stump that is capable of producing new shoots. 2 The permanent base of a coppiced tree.

store *See* single.

storks 1 *See Ciconia*; Ciconiidae; Ciconiiformes; and *Leptoptilos*. 2 (wood storks) *See Ibis*.

storm Common term for gales, squalls, rainstorms, or thunderstorms. It is used specifically for conditions associated with the active areas of low-pressure systems. 'Storm-force' winds (over 20.8 m/s) are, by definition, strong gales or winds.

storm beach Accumulation of coarse beach sediments built above the high-water mark by storm action. Gravel, shell debris, and other coarse materials are thrown into ridge or bank structures by waves during heavy storms.

storm petrels *See* Hydrobatidae; *Oceanites*; *Oceanodroma*; and Procellariiformes.

storm surge Rise or piling-up of water against the shore during a storm, as a result of wind stresses acting on the surface of the sea and of atmospheric-pressure differences. If a storm surge occurs at the time of highest spring tides, flooding of coastal areas may result, as happened in 1953 in East Anglia, England.

stouts *See* Tabanidae.

Strahler climate classification Little-used system for describing climates, devised in 1969 by A. N. Strahler, in which world climates are related to the main air masses that produce them, as: (a) equatorial/tropical air masses, producing low-latitude climates; (b) tropical and polar air masses, producing mid-latitude climates; and (c) polar and arctic air masses, producing high-latitude climates. Subsets of these are based on variations in temperature and precipitation to give 14 regional types, plus upland (highland) climates, which are regarded as a separate category. *See also* Köppen climate classification; and Thornthwaite climate classification.

straightnosed pipefish (*Nerophis ophidion*) *See* Syngnathidae.

strain The physical manifestations of rock deformation, e.g. changes in volume or shape.

Straits rhododendron (*Melastoma malabathricum*) *See Melastoma*.

stramineous Straw-coloured.

strandflat Shore platform up to 60 km wide, found along the coasts of Greenland, Iceland, Norway, and Spitzbergen. It may be the result of combined glacial and marine processes.

strandline Shoreline of a marine or lacustrine environment. The term is applied most commonly to ancient shorelines. The development of a strandline requires that the relative positions of land and water remain stable long enough for features to form. Subsequent displacement may be caused by a change in the level of the water or of the land.

strangler Plant that depends on another for physical support and ultimately suppresses the support plant by twining branches or aerial roots, e.g. strangler fig. Stranglers are most typical of tropical rainforest communities.

strangles Acute, contagious disease which affects young horses; mules and donkeys may be affected but the disease is less severe in these animals. Symptoms include inflammation of the upper respiratory tract with a mucopurulent nasal discharge. The disease may be fatal. The causal agent is *Streptococcus equi*.

strangling fig Fig tree that germinates high in a host tree and sends roots to the ground which eventually anastomose and as they grow, envelop and kill the supporting tree. The banyans differ in having roots descending from the limbs as well so that a grove of closely growing, stout roots develops.

strata *See* stratum.

stratified random sample (partial random sample) In statistics, a modification of the random sample that is particularly useful when obvious heterogeneity exists in the community, area, etc. to be investigated. In such instances a simple random sample may fail to record sufficient replicates of a particular sub-category, or may do so only very inefficiently, so preventing a proper statistical monitoring of variability. In a stratified random scheme sample points are shared among the main types present, then allocated at random within those sub-categories.

stratiformis From the Latin *stratus* meaning 'flattened' or 'spread out' and *forma* meaning 'appearance', a species of cloud consisting of an extensive level sheet or layer, found in altocumulus, stratocumulus, and sometimes cirrocumulus. *See also* cloud classification.

stratigraphic correlation Geological study concerned with establishing geochronological relationships between different areas, based on geological investigations of many local successions.

stratigraphy The branch of the geological sciences concerned with the study of stratified rocks in terms of time and space. It deals with the correlation of rocks from different localities. Correlation methods may involve the use of fossils (biostratigraphy), rock units (lithostratigraphy), or geological time units or intervals (chronostratigraphy).

Stratiomyidae (soldier flies; class Insecta, order Diptera, suborder Brachycera) Family of small to large flies which are usually flattened, with bright yellow, green, white, or metallic markings. The body lacks bristles, and has an annulated third antennal segment. Squamae are small, and the tibia is rarely spurred. The scutellum is often strongly developed, with spines or projections. Wing veins are crowded near the costa, and are more pigmented than the posterior veins. The adults are not usually strong fliers, and are often encountered

sitting on flowers. The larvae are associated with aquatic environments or with dung, and are carnivorous in either habitat. Most larvae have thick, leathery skin impregnated with calcareous deposits. The head is small and obvious, and there are a further 11 body segments. The family is distributed worldwide, and about 1400 species have been described.

stratocoenosis The community of a particular vegetation or physical habitat layer, e.g. the canopy layer of a woodland, the hypolimnion of a stratified lake.

stratocúmulus From the Latin *stratus* meaning 'flattened' or 'spread out' and *cumulus* meaning 'heap', a cloud composed of sheets or layers of grey to whitish appearance, typically with dark patches which are not fibrous. *See also* cloud classification.

stratopause The level that marks the maximum height of the stratosphere, at around 50 km. After high temperatures in the upper stratosphere (about 0 °C at the stratopause) temperature decreases with increasing altitude in the mesosphere above. *See also* atmospheric structure.

stratosphere The atmospheric layer above the troposphere which extends on average from about 10 to 50 km above the Earth's surface. The stratosphere is a major stable layer whose base is marked by the tropopause, with temperatures on overall average around −60 °C. Temperature in the lower stratosphere is isothermal but increases markedly in the upper part, to reach a maximum of about 0 °C at the stratopause. High stratospheric temperatures result from absorption of ultraviolet radiation (0.20–0.32 μm wavelengths) by ozone concentrated at 15–30 km. Due to low air density, ozone concentrated in small amounts is particularly effective in absorbing radiation, giving high temperatures at 50 km. The isothermal condition at the base of the stratospheric inversion layer creates stability, which generally limits vertical extensions of cloud and leads to the lateral spreading of high cumulonimbus cloud with characteristic anvil heads. *See also* atmospheric structure.

stratotype Fossil used to define the boundaries of a given rock or stratal unit.

strato-volcano Volcano built up of layers of lava alternating with beds of ash and other pyroclastics. Many of the largest volcanoes are of this type, and include Mt. Fuji (Japan) and Mt. Egmont (North Island, New Zealand).

stratum (pl. strata) Lithological term applied to rocks that form layers or beds.

stratus From the Latin *stratus* meaning 'flattened' or 'spread out', a cloud of flat, uniform base, of grey appearance, and through which the Sun may be outlined clearly when the cloud is not too dense. *See also* cloud classification.

strawberry *See Fragaria*.

strawberry tree (*Arbutus unedo*) *See Arbutus*.

streak 1 General term for a virus disease in a (usually monocotyledonous) plant in which streaks of yellow colour or necrosis occur on the leaves. 2 The colour of a mineral's powder, usually produced by scratching an unglazed porcelain plate, which may be different from the mineral's colour in mass.

streak lightning An electric discharge with a branching appearance of the main channel. It may flash between cloud and air or between cloud and ground.

streaming Metabolically active movement of the particulate and fluid constituents of the protoplasm. This can occur within a cell, laterally through protoplasmic material connecting cells, and also longitudinally through files of connected cells.

stream order Measure of the position of a stream (defined as the reach between successive tributaries) within the hierarchy of the drainage network. A commonly used approach allocates order '1' to unbranched tributaries, '2' to the stream after the junction of the first tributary, and so on. It allows a quantitative analysis of the network.

stream terrace (river terrace) Fragment of a former valley floor that now stands well above the level of the present floodplain. It is caused by stream incision, which may be due to uplift of the land, to a fall in sea-level, or to a change in climate.

Streblidae (class Insecta, order Diptera, suborder Cyclorrapha) Small family of flies in which the adults are exclusively parasitic on bats. The head is fixed to the thorax and the eyes, if present, are small. The antennae are two-segmented, and set in pits. The palps are leaf-like, and project forward, but are not sheathed. The flies may have wings, which are shed frequently. Females deposit fully developed larvae which pupate almost immediately. In *Ascodipteron* species the female undergoes a dramatic transformation from a winged insect to a bag-like sac once she is attached behind the ear of a bat of the genus *Miniopterus*. She sheds her wings and legs to achieve this transformation. The family is found mainly in the tropics and warm regions; 250 species have been described.

Strelitzia (family Strelitziaceae) Genus of of large herbs (but a few with a woody trunk), which have distichous leaves like those of bananas. The flowers are held in erect, harshly coloured, orange and blue inflorescences, subtended by vividly coloured bracts, and many are cultivated as bird-of-paradise flowers. There are five species occurring in southern Africa.

Strelitziaceae Small family of large herbs, or plants which have a woody trunk and petiolate leaves resembling those of bananas. The flowers are bisexual and trimerous, with an inferior ovary. The fruit is a capsule, the seeds sometimes arillate. There are three genera, with eight species, occurring in Africa and America.

Strepsirhini (cohort Unguiculata, order Primates) Suborder that includes the lemurs, bushbabies, lorises, and potto. All members of these groups possess a moist rhinarium and a cleft upper lip bound to the gum, and these, together with other features (including the proportion of proteins they share), suggest that they form a coherent group

which may be contrasted with the other suborder of Primates, the Haplorhini. According to this classification, Strepsirhini and Haplorhini replace the suborders Prosimii and Anthropoidea.

strep throat Sore throat which results from infection of the tissues by *Streptococcus pyogenes*.

Streptococcaceae Family of bacteria in which the cells are Gram-positive; spherical or ovoid; and occur in pairs, in groups of four, or in chains. Usually they are non-motile. They are chemo-organotrophic, and can grow in the presence or absence of air. They are found in a wide range of habitats.

Streptococcus (family Streptococcaceae) Genus of Gram-positive, non-motile bacteria in which the cells are spherical to ovoid, and generally occur in pairs or chains. There are many species, found chiefly as parasites and pathogens in warm-blooded animals, including humans. The genus includes the causal agents of tonsillitis (*S. pyogenes*), scarlet fever (*S. pyogenes*), pneumonia (*S. pneumoniae*), and dental caries (e.g. *S. mutans*). Not all species are harmful; some are used in the manufacture of certain dairy products, e.g. yoghurt and butter.

Streptomyces (family Streptomycetaceae, order Actinomycetales) Genus of bacteria in which the spore-bearing mycelium is variously coloured, often green or blue. Many antibiotics are obtained from species of *Streptomyces*: e.g. streptomycin, erythromycin, kanamycin, and tetracyclines. There are hundreds of species. They are mostly saprotrophic, and found in soils, for example. A few can be pathogenic, e.g. *S. scabies* causes common scab of potato.

Streptomycetaceae (order Actinomycetales) Family of aerobic bacteria which form a well-developed, non-fragmenting mycelium. Chains of spores are formed by division of hyphae held aloft from the substrate. There are four genera (including *Streptomyces*), and many species. They are found mainly in soil.

streptomycin Antibiotic synthesized by the bacterium *Streptomyces griseus*. It functions by binding to certain ribosomal subunits in pathogenic bacteria, thereby decreasing their rate of protein synthesis and causing the production of faulty proteins.

Streptopelia (turtle doves; family Columbidae) Genus of medium-sized, slim doves, some of which have rufous and black upper-parts, others being a uniform pale brown or mauve. They have neck markings in distinct patches, or as a narrow, half neck-collar. They inhabit woodland and open cultivated land, feed on seeds and insects, and nest in trees and bushes. *S. decaocto* (collared dove) has recently spread westwards from Asia to colonize Europe. There are 16 species, many migratory, found in Europe, Africa, Asia, Indonesia, and the Philippines.

Streptopelia decaocto (collared dove) *See Streptopelia*.

stress 1 (ethol.) Physiological condition, usually affecting behaviour, produced by environmental or psychological pressures. 2 (geol.) The system of compressive, tensional, or shearing forces that act within or on a body to produce observable strain.

striate Marked with fine lines, ridges, or furrows.

striation Narrow groove or scratch cut in exposed rock by the abrasive action of hard rock fragments embedded in the base of a sliding glacier. This provides a useful clue regarding the direction of ice movement in formerly glaciated areas.

stridulate To produce sound by rubbing a file across a membrane. Insects have a wide variety of mechanisms for sound production. In some of the most common examples a file on one wing rubs across a roughened surface on the other wing, or a file on the leg is drawn across the edge of the wing. The volume of sound production achieved by these mechanisms is often startling. The sound may be amplified by resonation in a wing or (e.g. in mole crickets) by causing a column of air to resonate in a chamber excavated in the ground and shaped for the purpose.

Strigidae (owls; order Strigiformes) Family of small to large owls which have brown, grey, and black, cryptically marked plumage. They have facial discs, and many have 'ear' tufts. Their claws are not pectinate. They inhabit forest, grassland, and desert; feed on fish, mammals, birds, and insects; and nest in tree cavities or burrows. There are 22 genera, with 122 species, some migratory, found worldwide.

Strigiformes (owls; class Aves) Order of small to large, mostly nocturnal birds of prey, which have large heads with large, forward-facing eyes, short necks, and short, strong, hooked bills. Their wings are broad and rounded with soft tips for silent flight; their tails are short to medium-length; and their legs are short to long, with zygodactylous toes. They inhabit forest, open country, grassland, and desert; feed on fish, mammals, birds, and insects; and nest in tree cavities or burrows. There are two families, Strigidae and Tytonidae, found worldwide.

strigil Brush of hairs, one of which is found on each of the forelimbs of certain insects, and which is used for grooming. The term is usually applied to structures in the Hymenoptera and Lepidoptera.

strike The compass direction of the horizontal line on an inclined plane.

strike ridge Elongated hill developed along the strike of a bed that is more resistant than its adjacent strata. *See also* cuesta.

stringy bark Group of *Eucalyptus* species, named from their distinctive bark.

striped bass (*Morone saxatilis*) *See* Percichthyidae.

striped catfish *See* Plotosidae.

striped goby (*Gobius vittatus*) *See* Gobiidae.

strip mining Mining in which large strips of land are excavated in order to extract materials without sub-surface tunnelling. It may result in short- and long-term environmental damage.

Strix (owls; family Strigidae) Genus of medium to large owls which have barred, spotted, or streaked under-parts. They have large, rounded heads, with obvious facial discs and no 'ear' tufts. They inhabit mainly forests and woodland; feed on mammals, birds, reptiles, and insects; and nest in holes in trees or rocks, or on the ground. There are 11 species found in Europe, N. Africa, Asia, and N., C., and S. America.

stroma 1 (mycol.) Cushion-like mass of fungal tissue in or upon which spore-bearing structures may develop. 2 The matrix of chloroplasts, within which the grana are embedded. In addition to containing starch granules and oil droplets it contains the enzymes responsible for the mediation of the dark reactions of photosynthesis.

Stromateidae (butterfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish, which have a deep, oval-shaped body; long but low dorsal and anal fins; a small mouth; and a strongly forked tail-fin. *Stromateus fiatola* (butterfish), 50 cm, and *Peprilus simillimus* (pompano) of the Pacific, tend to frequent fairly shallow tropical to subtropical waters. There are about 13 species, occurring in the Indo-Pacific region.

Stromateus fiatola (butterfish) *See* Stromateidae.

Stromatocystites walcotti The earliest known representative of the echinoderm group the Edrioasteroidea. It had a pentagonal shape with five distinct 'arms' apparent on the surface of a flexible, many-plated test. It existed during the Lower Cambrian.

stromatolite Rock-like or firmly gelatinous structure, built up over long periods of time from many layers or mats of cyanobacteria together with trapped sedimentary material. Stromatolites are found in shallow marine waters in warmer regions. Some are still in the process of being formed, e.g. those in Shark Bay, W. Australia; fossil stromatolites dating from the Early Precambrian are also known, although it is not certain that these were formed by cyanobacteria. *See also Schizothrix*.

Stromatoporoidea Extinct group that has been attributed to the hydrozoans, sponges, foraminifera, bryozoans, algae, or regarded as a phylum with no modern representatives. Stromatoporoids are calcareous masses built up of horizontal laminae and vertical pillars. The upper surfaces show a pattern of polygonal markings and may have swelling and stellate grooves. They are found in limestones of Cambrian to Cretaceous age, often forming reefs in Ordovician to Devonian times.

strongyloidiasis Disease of humans and some other Mammalia caused by infestation with threadworms (class Trematoda) of the genus *Strongyloides*. The parasites have only one host and find their way to the duodenum. The most common symptom is chronic diarrhoea.

strontionite Mineral, specific gravity 3.7, hardness 3.5–4.0, chemical composition $SrCO_3$, named after the type locality of Strontian, Highland Region (Argyll), Scotland. It occurs in low-temperature hydrothermal veins, often in limestone, and in association with celestine, barite, and calcite. It is distinguished by its high specific gravity and its solubility, with effervescence, in dilute hydrochloric acid. It can vary in colour from white to pale green, grey, or pale yellow, and it has a white streak, and a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are prismatic or acicular, but they can also be fibrous and massive.

strontium-87 *See* radiometric dating.

Stropharia (family Strophariaceae) Genus of fungi, with mushroom-shaped fruit bodies in which the fleshy cap bears a separable pellicle and is often slimy. The stipe is not readily broken from the cap and has an annulus. The gills become brown with maturity. *Stropharia* species are found in grassland, on dung, etc.

Strophariaceae (order Agaricales) Family of fungi in which the spores in masses appear yellowish-brownish or dusky-brown. The stipe and pileus of the fruit body are confluent. There are several genera, found on soil, dung, wood, etc.

Strophomenida (class Articulata) The largest order of brachiopods, now extinct, in which one valve is usually convex and the other flat or concave. There is a straight hinge line. The pedicle foramen is filled by one plate in each valve in adult shells, the pedicle having degenerated and been lost. Attachment is by cementation of the pedicle valve with or without tubular spines from the valves. The shell structure is pseudopunctate. Strophomenida appeared in the Lower Ordovician and became extinct in the Lower Jurassic. The order comprises four suborders, nine superfamilies, and 400 genera.

structural gene Gene that codes for the amino-acid sequence of a protein. *Compare* regulatory gene.

structuring method Any technique for sorting data to reveal the important patterns. Classification and ordination methods are examples of structuring methods.

Struthio (ostrich; family Struthionidae) Monotypic genus comprising *S. camelus* which is the largest living bird. Males are black with white wing and tail plumes, females are brownish-grey. Ostriches have long necks, small heads, and short, flat bills. Their legs are long with bare thighs, and their feet have only two toes. They are flightless and gregarious, running very swiftly. They feed on plants, berries, and seeds, and nest on the ground. They are farmed for their decorative plume feathers. They are confined to Africa.

Struthionidae (ostrich; order Struthioniformes) Family that comprises the one genus *Struthio*.

Struthioniformes (ostrich; class Aves) Order that comprises only the monotypic family Struthionidae.

strychnine *See Strychnos*.

Strychnos (family Loganiaceae) Genus of trees and woody climbers which have hook-like tendrils. The fruit is a berry, some fruits containing seeds that are exceedingly poisonous, due to the presence of alkaloids. Curare is obtained from *S. toxifera* of

tropical America; strychnine from *S. nux-vomica* of tropical Asia. There are 200 species occurring in the tropics.

stub Tree that is intermediate between a stool and a pollard.

stump-tailed skink *See Tiliqua rugosa*.

sturgeon, common (*Acipenser sturio*) *See* Acipenseridae.

Sturnidae (starlings, mynahs; order Passeriformes) Family of medium-sized birds, most of which are black or dark in colour, many with a highly iridescent, purple, blue, green, and bronze gloss. Some have bare areas of skin and waftles on the face, and some are crested. They have straight, fairly slender bills, short and rounded to long and pointed wings, and most have short, square tails. They are highly gregarious and are arboreal to terrestrial, running well. They are good mimics and many, especially mynahs, are kept as cagebirds. They inhabit forests, open country, and urban areas, are omnivorous, and nest in holes in trees, banks, or buildings. *Sturnus vulgaris* (starling) has been introduced to N. America, S. Africa, Australia, and New Zealand. There are about 25 genera, with 108–110 species, some migratory, found in Europe, Africa, Asia, Australasia, and Pacific islands.

Sturnus vulgaris (starling) *See* Sturnidae.

Sturt's desert pea (*Clianthus formosus*) *See Clianthus*.

Stylasterina (branched hydrocorals; class Hydrozoa) Order of Cnidaria similar to Milleporina, but without free medusae. Sex products are formed on aborted medusae in special cavities. Stylasterina are known from the Upper Cretaceous to Recent.

style 1 (bot.) Extension of the carpel which supports the stigma. 2 (zool.) In some Mollusca, a crystalline rod-like structure which projects into the stomach where it is abraded to release enzymes. 3 In some insects, a bristle at the end of the antenna. 4 In some insects, a rod-like abdominal appendage.

stylets In certain groups of insects, mainly Hemiptera (true bugs), tubular, sucking mouthparts formed from mandibles and maxillae that are modified into slender, flexible structures. The two pairs of maxillary stylets are pressed closely together and the separate salivary and food canals pass between them. The mandibular stylets slide freely and independently along the sides of the maxillary stylets. *See also* rostrum.

Stylidiaceae (trigger plants) Family of annual and perennial herbs and some shrubs, many of which are xerophytes. The leaves are alternate, or often in a basal rosette, simple, often linear and almost grass-like, and without stipules. The flowers are held on a scape, in racemes or cymes. They are irregular and bisexual or unisexual, with five persistent sepals, usually united to form two lips. The petals are partially fused, forming a deeply lobed corolla with a small lower lobe and two pairs of upright lobes. There are two stamens, often fused with the style to form a column which curves partially over the lower lip. When an insect lands on the lower lobe of the flower the column springs up and down, which assists the transfer of pollen to the insect: this mechanism gives the plants their common name. The ovary is inferior, with two fused carpels and one or two multi-ovular locules. The fruit is a capsule containing the small seeds. The family is divided into two subfamilies and two tribes separated by their petal and stamen arrangement. One subfamily contains only one genus, *Donatia*, which was formerly assigned to its own family (Donatiaceae). A few species are cultivated as ornamentals. There are six genera, with about 150 species, found in tropical and temperate regions of Australia and New Zealand, and in restricted regions of Asia and S. America.

Stylidium (trigger plants; family Stylidiaceae, subfamily Stylidioideae, tribe Stylideae) Genus of herbs and evergreen shrubs with alternate leaves which are often held in a basal rosette. The grass-like leaves are narrow and linear, with no stipules. The flowers are held in racemes and are irregular, with the five sepals united into a two-lipped, persistent calyx. The petals form a lobed corolla with two upright, paired lobes, and a small descending one. The petals are united at the base. The two stamens are fused to the style. Several species have an irritable gynostemium which, when released by touch, springs from side to side, assisting in the distribution of the pollen. The fruit is a capsule containing the numerous small seeds. Several shrub species of W. Australia are cultivated. There are 114 species, found in Australia and SE Asia.

Stylites *See* Isoetaceae.

Stylommatophora (class Gastropoda; subclass Pulmonata) Order of pulmonate gastropods with two pairs of tentacles; they are predominantly terrestrial. Forms with and without shells are common. Eyes are present at the tips of the posterior pair of tentacles. The order first appeared in the Mesozoic.

Styphelia (family Epacridaceae) Genus of erect or spreading shrubs with sessile or short-stemmed, often lanceolate leaves which are rigid and pointed. The flowers are axillary, usually solitary, with a cylindrical corolla with narrow lobes which are hairy on the inside and recurved, exposing the stamens. The ovary is composed of five uniovular locules. The style is composed of many filaments which are longer than the corolla. The fruit is a drupe. There are 11 species, and the genus is endemic to Australia, including Tasmania. The plants are often components of coastal or mountain plateau or heath communities.

Styrax (family Styracaceae) Genus of trees and shrubs, several of which yield a useful resin, benzoin or gum benjamin, produced by wounding the wood. There are 130 species, occurring in warm-temperate and tropical regions.

sub-alpine forest Conifer-dominated forest which occurs mainly in the sub-alpine zone of temperate latitudes, but with a few extensions south of the Tropic of Cancer. The elevation of the zone increases with decrease in latitude. Generically this

forest is closely related to the boreal forest and indeed the two types have a minority of species in common.

Sub-arctic current (Aleutian current) The oceanic current that flows eastwards south of the Aleutian Islands and parallel to, but to the north of, the N. Pacific current. The water mass is a mixture of water from the Kuroshio and Oyashio currents.

sub-Atlantic A colder, wetter climatic phase which followed more continental sub-Boreal times. The change from sub-Boreal to sub-Atlantic conditions in Britain is roughly coincident with the transition from Bronze to Iron Age cultures. The sub-Atlantic marks a period of renewed peat growth on bog surfaces that in late sub-Boreal times were sufficiently dry and humified to support heathy vegetation, e.g. *Calluna vulgaris* (ling, heather). This renewed peat growth gives a major recurrence surface, the Grenz horizon, which in Britain defines the zone VIIb/zone VIII (sub-Boreal/sub-Atlantic) boundary of the standard pollen stratigraphy.

sub-Boreal From Scandinavian evidence, a cooler, drier, more continental climate phase that followed the Atlantic climatic optimum (though with summers still warmer than those at present). In Britain, clear evidence for climatic change (e.g. differing peat deposits), is lacking, and the Atlantic/sub-Boreal boundary is usually taken as the point of marked decline in elm pollen in the pollen stratigraphy. The reason for the elm decline, which, irrespective of elm species, is characteristic of pollen chronologies throughout Europe, has been the subject of much research. Hypotheses range from colder climate to epidemic disease to anthropogenic causes. The latter is linked to the selective use of elm as fodder for stalled livestock, now thought to have been a characteristic practice of Neolithic, forest-dwelling peoples. In many pollen chronologies this initial elm decline is followed quickly by a general 'landnam' decline in tree pollen. The sub-Boreal forms pollen zone VIIb, and lasted from about 5000 to 2800 BP.

subboscus *See* boscus.

subcaudal Beneath the tail.

subclimax Strictly, the penultimate stage in a succession to a climatically controlled climax community (as in monoclimax theory). Typically, a subclimax community persists for a long time—for example the forests of Boreal times may be considered subclimax to the early Atlantic forests of the post-glacial climatic optimum.

subclinical infection 1 Disease or infection in which symptoms are barely discernible. 2 The period in a disease before the onset of recognizable symptoms.

subcutaneous In vertebrates, immediately below the outermost epidermal layer.

subduction The process of consumption of lithospheric material at convergent plate boundaries.

sub-formation In phytosociology, a vegetation grouping used by the Uppsala school of phytosociology, and denoting a geographically distinctive unit of a major formation.

subglacial *See* englacial.

subhymenium In certain fungi of the Basidiomycotina or Ascomycotina, a layer of tissue lying beneath the hymenium.

sub-imago (dun) In members of the Ephemeroptera, and unique among the Insecta, a pre-adult, winged stage through which the insects pass. The aquatic nymphs emerge on the surface of water or on rocks, and take from a few seconds to several minutes to change into sub-imagos. Emergence times vary from species to species, and the sub-imago may last from minutes to a whole day before moulting to the adult stage. Some exotic species breed and die in the sub-imaginal stage.

sub-isomyarian Applied to a condition in some pelecypods in which the two adductor muscles are of nearly, but not quite, equal size.

sublimation Direct evaporation from ice. In meteorology, the term is also applied to the reverse process, in which water vapour changes directly to the solid phase. *See also* ablation.

sublingual glands A pair of salivary glands located beneath the tongue.

sublittoral zone 1 In freshwater ecosystems, an alternative name for the limnetic zone. 2 The sea-shore zone lying immediately below the littoral (intertidal) zone and extending to about 200 m depth or to the edge of the continental shelf. Red and brown algae are characteristic of this area. Typical animals include sea anenomes and corals on rocky shores, and shrimps, crabs, and flounders on sandy shores. The zone may alternatively be called the subtidal zone. It is approximately equivalent to the circalittoral zone.

submarine canyon Deep, steep-sided valley cut into the continental shelf or slope, whose axis slopes seaward as much as 80 m/km. The development of submarine canyons is thought to have originated through erosion by turbidity currents. However, few turbidity currents have been recorded from submarine canyons that have been studied.

submaxillary gland One of a pair of salivary glands located at the angles of the jaw.

submergence marsh The lower zone of a salt-marsh, from the mean high-water level of neap tides to the general level of mean high water. Typically, this zone experiences more than 360 submergences per annum, usually with more than one hour of submergence during daylight each day. Continuous exposure never exceeds nine days. *Compare* emergence marsh.

submersible Underwater vehicle, used for oceanographic investigation or offshore engineering. These small submarines may be manned or unmanned.

sub-nodum *See* nodum.

Subselliflorae (order Pennatulacea) Suborder of sea pens which first appeared in the Cretaceous. They are characterized by polyps which are united at their bases by ridge-like or leaf-like structures. The suborder contains three families, with 13 genera.

subsequent stream Stream whose course follows a line of geological weakness, perhaps the strike of a soft bed, or a fault. Such a stream may develop after consequent rivers have been established.

subsessile Nearly sessile.

subsidence (meteorol.) Downward movement of air, characteristically gentle (1–10 cm/s) often in large anticyclones, related to the divergence in lower layers near the ground surface. Subsidence results from radiation cooling or from convergence of air horizontally in the upper troposphere. Subsidence typically brings settled weather, with evaporation of cloud drops by adiabatic warming in the subsiding air mass, causing cloudless skies above the friction layer near the surface, where in winter fog and low cloud may prevail when moisture is sufficient. *See also* divergence.

subsoiling The breaking up of subsoils, usually because they are compacted, without inverting them, by using a chisel-like device that is pulled through the soil.

subspecies Technically, a race of a species that is allocated a Latin name. The number of races recognized within a species and the allocation of names to them is something of an arbitrary procedure. Systematic and phenotypic variations do occur within species, but there are no clear rules for identifying them as races or subspecies except that they must be (a) geographically distinct, (b) populations, not merely morphs, and (c) different to some degree from other geographic populations. *See also* species.

substitutional load In genetics, the cost in genetic deaths to the population of replacing one allele by another (a mutation) in the course of evolutionary change.

substrate 1 (biochem.) The reactant acted upon by an enzyme. 2 (substratum) Any object or material upon which an organism grows or to which an organism is attached; an underlying layer or substance.

substrate mycelium Part of a mycelium that remains in contact with the substrate.

substratum *See* substrate.

subtropical high Surface high-pressure cells, especially prominent and persistent over oceans at around 30° latitude. The anticyclones develop below the subtropical jet from subsiding air. The development tends to shift equatorward in winter and poleward in summer. The high pressure is weaker over continents in summer. *See also* Azores high; and Bermuda high.

subtropical jet stream Jet stream of subtropical latitudes. The change from a westerly direction in winter to an easterly one in summer influences the surface wind changes that mark the summer monsoon. The jet is related to a marked temperature gradient in the upper troposphere. The westerly jet moves equatorward in winter and is associated with subsiding air and settled surface weather. In summer the jet moves poleward. At the seasonal extremes it tends at times to merge with the polar-front jet.

subzone Division of the fundamental unit (zone) used in biostratigraphy. The demarcation of a subzone is based on the fossil subspecies or assemblage contained within the rock sequence studied.

succession Sequential change in vegetation either in response to an environmental change or induced by the intrinsic properties of the plants themselves. Classically, the term refers to the colonization of a new physical environment by a series of vegetation communities until a final equilibrium state, the climax, is achieved. The presence of the colonizers, the pioneer plants, modifies the environment so that new species can join or replace the initial colonizers. Changes are rapid at first but slow to a more or less imperceptible rate at the climax stage. The characteristic sequence of developmental stages, i.e. nudation, migration, ecesis, competition, reaction, and stabilization, is termed a sere.

succinyl coenzyme A Intermediate compound in the conversion of alpha-ketoglutaric acid to succinic acid during the citric-acid cycle, a process linked to the formation of the energy-rich guanosine triphosphate (GTP). Succinate is not always the final product as the succinyl coenzyme A may be employed for acylation reactions or to initiate porphyrin synthesis.

succubous (of liverwort leaves) *See* Jungermanniales.

succulent Fleshy.

sucker 1 Underground shoot arising adventitiously from the roots or lower stem of a tree or shrub and emerging from the soil to form a new plant, initially nourished by the parent plant. In cultivated species where grafting is practised (e.g. roses and fruit trees), production of suckers from the stock may seriously detract from the vigour of the grafted scion. 2 Organ with which an animal attaches itself to a surface. 3 *See* Catostomidae.

sucker-footed bat *See* Thyropteridae.

sucker-loach *See* Gyrinocheilidae.

sucking lice *See* Anoplura.

sucrase (invertase) Enzyme responsible for the catalytic hydrolysis of sucrose to fructose and glucose.

sucrose Disaccharide, composed of fructose and glucose, which is a common storage and transport sugar in plants. It is known commercially as cane or beet sugar.

suction pressure (diffusion pressure deficit) The net pressure that causes water to enter plant cells. When cells are fully turgid they have no suction pressure.

Suctoria (class Ciliatea) Subclass of protozoa in which mature individuals lack both cilia and a cytostome. Mature forms typically are stalked and attached to a substrate. They have tentacles which are used for capturing and ingesting prey (mainly other ciliate protozoa). Reproduction occurs by budding, which produces free-swimming, ciliated, mouthless larval forms. There is one order, found in freshwater and marine habitats.

Suctorida (subclass Suctoria) Order of protozoa which have the characteristics of the subclass.

Sudanese park-steppe floral region Part of Good's (1974) African subkingdom within his Palaeotropical kingdom, which has a not very rich flora in which species of *Acacia*, grasses, and palms tend to dominate the vegetation.

suffocation disease Disease of rice in which reddish-brown patches spread from the tips of the leaves downwards; the roots of the plants blacken and rot. The condition is encouraged by poorly-drained soils and appears to be associated with the presence of *Pseudomonas putida* in the soil.

sugar Member of a group of water-soluble carbohydrates that have a low molecular weight and are composed of one or more simple compounds (monosaccharides).

sugar apple (*Annona squamosa*) *See Annona*.

sugar beet (*Beta*) *See* Chenopodiaceae.

sugarbirds *See* Promeropidae.

sugarcane (*Saccharum officinarum*) *See Saccharum*.

sugar kelp *See* sea-belt.

sugar loaf *See* bornhardt.

sugar palm *See Arenga*.

Suidae (pigs; order Artiodactyla, suborder Suiformes) Family of omnivorous mammals which dig for roots and also eat other plant material and invertebrates. The legs are relatively short, and the hair sparse and coarse. The nostrils are in a forward-facing disc at the end of the snout. The tusks, formed from the upper canines, are curved upward, and all the canines grow persistently in the male; in the female the canines have closed roots and do not grow continuously. The skull is long, and low in front. The pig family can be traced back to the initial radiation of the artiodactyls, near the Eocene–Oligocene transition, and their evolution was confined to the Old World, where they are distributed widely. They never penetrated the New World except as companions to humans. There are nine species, in five genera.

Suiformes (Suina; superorder Paraxonia, order Artiodactyla) Suborder comprising the Suidae (pigs), Tayassuidae (peccaries), and Hippopotamidae (hippopotamuses), together with ancestral forms. They are non-ruminant artiodactyls in which the upper canine teeth form tusks; the cheek teeth are bunodont; the stomach has three chambers, except in the Suidae, where it has two; and the limbs bear four digits, except in the Tayassuidae in which the hind limbs bear three. The suborder appeared first during the Eocene.

Suillus (family Boletaceae) Genus of boletes in which the spore print is olive, cinnamon, or brownish in colour. In most species the surface of the cap is slimy. There are many species, found on the ground in association with conifer trees.

Suina *See* Suiformes.

Sula (gannets, boobies; family Sulidae) Genus of large sea birds, many of which are white with black flight feathers, others brown with varying amounts of white. They have long, stout bills, lacking nostrils; fairly long necks; long, pointed wings; and long, wedge-shaped tails. Their legs are short with large, totipalmate feet which are often brightly coloured. They inhabit islands and cliffs; feed on fish caught by diving from the air; and nest colonially on ledges, on the ground, or in trees. There are nine species, some migratory, found worldwide.

sulcal *See* sulcate.

sulcate (sulcal) Marked with ridges, grooves, or furrows.

Sulidae (gannets, boobies; order Pelecaniformes) Family that comprises the one genus *Sula*, although three species are sometimes placed in a separate genus, *Morus*.

sulphur (S) An element needed for plant life. It is found covalently bound, especially in proteins, where it stabilizes their structures. It is also involved in oxidation and reduction reactions. Sulphur-deficient plants become chlorotic and etiolated.

sulphur butterflies *See* Pieridae.

sulphur fungus (sulphur polypore) Common name for the fruit bodies of *Laetiporus sulphureus*, which are bracket-like, typically growing in tiers. The upper surface is irregular, and is initially a bright sulphur-yellow or orange-yellow but later fades to a dull whitish colour. The tubes on the under-side are sulphur-yellow with small, more or less circular pores. The spore print is white. They are found on various broad-leaved (living or dead) trees, particularly oak.

sulphur polypore *See* sulphur fungus.

sulphur tuft Common name for the dense clusters of fruit bodies of *Hypholoma fasciculare*, in which the cap is convex, 2–7 cm across, and is bright yellow becoming brownish towards the centre. The stem, flesh, and gills are yellow, although the gills later become dark brown. They are very common throughout the year on tree stumps.

sulphydryl (thiol) The radical group –SH.

sumac *See Rhus*.

sumatra Regional squall, usually occurring at night, in the Malacca Strait, accompanied by high winds, which veer from southerly to south-westerly and north-westerly. Extensive cumulonimbus cloud brings heavy rain, with thunder and lightning.

summation The addition of stimuli of different kinds, which may be perceived at more than one time and in more than one place, to produce a co-ordinated response in an animal. Summation is one of the integrating properties of the central nervous system.

sun animalcule Protozoon of the subclass Heliozoia, the name often referring specifically to *Actinophrys sol*.

sunbathing Exposure of its body to sunshine by an animal as a means of thermoregulation (mainly in poikilotherms) or to stimulate the production of vitamin D in the skin. Many animals prefer to rest in warm (but not hot) sunshine, thereby conserving

metabolic energy that otherwise would be needed to maintain body temperature.

sunbeam snake *See* Xenopeltidae.

sunbirds *See Anthreptes*; *Nectarinia*; and Nectariniidae.

sun-bittern *See* Eurypygidae.

Sundaland Name commonly given to the unit composed of Malaya, Sumatra, Java, and Borneo, with the intervening small islands, which are linked by the shallow water (less than 200 m) Sunda shelf, which was exposed during periods of low sea-level in the Pleistocene. The fauna of this region is fundamentally homogeneous and differs slightly from that of areas further north-west, despite the fact that Malaya today is linked by an isthmus to the Asian mainland.

sundews *See* Droseraceae.

sunfish *See* Centrarchidae; and Molidae.

sunflies *See* Syrphidae.

sunflower (*Helianthus annus*) *See* Compositae.

sungazer *See Cordylus giganteus*.

sungrebes *See* Heliornithidae.

sun orchid *See Thelymitra*.

sunshine recorder *See* Campbell–Stokes sunshine recorder.

super-adiabatic lapse rate A fall of temperature with increasing altitude greater than the usual dry adiabatic lapse rate, in conditions of intense heating over land or sea.

superb lyrebird (*Menura novaehollandia*) *See* Menuridae.

supercooled cloud Cloud containing pure water droplets at temperatures considerably below the nominal freezing level of 0 °C. With very pure water (i.e. free from pollutants) supercooling of liquid drops can occur down to around −40 °C—altocumulus cloud, for example is usually composed of water droplets at temperatures well below 0 °C. *See also* cloud seeding.

superdominance *See* overdominance.

supergene A segment of chromosome that is protected from crossing-over and so is transmitted intact from generation to generation, like a recon. The term is used to refer to several closely linked gene loci that affect a single trait or a series of interrelated traits, such as the genes coding for the expression of pin and thrum flower phenotypes in the primrose and other species of the genus *Primula*, and the set of gene loci controlling the colour and presence or absence of bands in the shell of the snail *Cepaea nemoralis*. Genes involved in the same biochemical function, e.g. those controlling the synthesis of tryptophan, are often clustered together in close linkage within the genome to form a supergene. The bacterial operon is one such example.

superimposed drainage *See* drainage.

supernormal stimulus Artificial stimulus that produces in an animal a response that is stronger than would be evoked by the natural stimulus it resembles. For example, in some birds incubation behaviour is stimulated by the presence of an egg, and the larger the egg the stronger the stimulus; in such birds a very large artificial egg may be incubated in preference to a much smaller real egg.

supersaturation The condition of air with humidity above the level required for saturation at a given temperature. Supersaturation, with a relative humidity over 100%, results when the temperature of pure air falls below its dew point. *See also* saturated air.

superspecies *See* species group.

superstage (geol.) Little-used chronostratigraphical unit which represents a body of rock often from a given geographical locality, or one defined by the presence of a given fossil assemblage.

supersuppressor *See* suppressor mutation.

suppression *See* suppressor mutation.

suppressor mutation (suppressor) In genetics, a second mutation that masks the phenotypic effects of an earlier mutation. This second mutation occurs at a different site in the genome (i.e. it is not a strict reversion); 'intragenic suppression' results from a second mutation that corrects the functioning of the mutant gene (e.g. a mutation of a different nucleotide in the same triplet, such that the codon then encodes the original amino acid); 'intergenic suppression' results from mutation of a different gene, the product of which compensates for the dysfunction in the first (e.g. a mutation that produces a mutant transfer-RNA molecule that inserts an amino acid in response to a nonsense codon, thus continuing a protein that would otherwise have been terminated). If a single suppressor mutation can suppress more than one existing mutation, it is said to be a supersuppressor. *Compare* reverse mutation.

supraglacial *See* englacial.

supralittoral zone The sea-shore zone immediately above the littoral fringe and beyond the reach of tidal submergence, though affected by sea spray.

supra-occipital The bone that forms the dorsal margin of the foramen magnus.

supratragus In Mammalia, the upper part of the pinna.

surf Breaking waves in the area between the shoreline and the outermost limit of breaking wave.

surface inversion Temperature inversion in the lower atmospheric layers, extending upwards from the Earth's surface. The condition results for example from radiation cooling of the ground and the air above, or from advection of warm air over cold surfaces.

surface wind The wind close to the Earth's surface, the velocity of which is usually measured at a standard height of 10 m. Surface-wind velocity is reduced by the frictional effect of the underlying surface. The actual wind is a balance of pressure gradient force, Coriolis force, and frictional effects.

surf perch *See* Embiotocidae.

surf scoter (*Melanitta perspicillata*) *See Melanitta*.

surf wave *See* spilling breaker.

surgeonfish (doctorfish) *See* Acanthuridae.

Surinam toad *See Pipa pipa*.

surra Disease of domestic animals which occurs in parts of Africa, Asia, and S. America. The causal agent is *Trypanosoma evansi*. A wide range of animals may be affected; in some the infection may be almost symptomless while in others (e.g. horses) the disease is more serious, with fever and emaciation. The parasite is transmitted by insects, especially blood-sucking horseflies (Tabanidae).

'survival of the fittest' *See* natural selection.

survivorship curve Graphical description of the survival of individuals in a population from birth to the maximum age attained by any one member. Usually it is plotted as the logarithm of the number of survivors as a function of age. If a population has a constant mortality rate the graph will be a straight line.

suspended load The part of the total load of a stream that is carried in suspension. It is made up of relatively fine particles that settle at a lower rate than the upward velocity of water eddies. Its highest concentration is in the zone of greatest turbulence, near the bed. It reaches a maximum in shallow streams of high velocity.

Svedberg unit The unit of measurement in which sedimentation coefficients are expressed. It is equal to 10^{-13} seconds.

Swainsona (family Leguminosae) Genus of herbs and small shrubs which are either glabrous or with close-lying hairs. The leaves are alternate, and narrowly pinnate with many leaflets, often with stipules. If present, the stipules are usually broad at the base and herbaceous. The irregular flowers are held in axillary racemes, and are usually violet, purple, or red. The calyx tube has teeth of unequal length, and the petals are held in a butterfly shape with the lower two forming a keel which is often longer than the two lateral petals. The upper stamen is free; the remaining nine are fused together. The superior ovary contains numerous ovules, although, characteristically of legumes, there is only one carpel. The pod is ovoid or oblong, and often turgid. There are about 80 species, all endemic to Australia and New Zealand.

swallower (*Chiasmodon niger*) *See* bathypelagic fish; and Chiasmodontidae.

swallow hole *See* doline.

swallows 1 *See* Hirundinidae; and *Hirundo*. 2 (wood swallow) *See* Artamidae.

swallowtail butterflies *See* Papilionidae.

swallow-tanager (*Tersina viridis*) *See* Tersinidae.

swamp Wet area that is normally covered by water all year and that is not subject to drying out during the summer. *Compare* fen; and marsh.

swamp cypress 1 (*Actinostrobus pyramidalis*) *See Actinostrobus*. 2 (Chinese swamp cypress) *See Glyptostrobus*.

swamp eel *See* Synbranchidae.

swamp sepetir *See Sindora*; and *Pseudosindora*.

swan animalcule The ciliate protozoon *Lachrymaria olor*.

swan goose (*Anser cygnoides*) *See Anser*.

swans *See* Anatidae; and *Cygnus*.

swash The turbulent uprush of water that occurs when a wave breaks on a beach. It is an important mechanism for transporting sand and shingle landwards.

sweat bees Small bees belonging to the families Halictidae and Apidae-Meliponini (stingless bees) which are attracted to human sweat, especially in warm-temperate and tropical climates.

sweat flies *See* Syrphidae.

sweat gland In Mammalia, one of the glands located in the skin which secrete a dilute solution of blood salts whose evaporation aids surface cooling.

sweeper *See* Pempheridae.

sweep net Finely meshed net, usually with a round mouth, used for sampling insects from vegetation. Its advantages lie in its simplicity and speed, and it is able to collect relatively dispersed insect species on top of the vegetation. It cannot be used on very short vegetation.

sweepstakes dispersal route Term coined by G. G. Simpson (1940) to describe a possible route of faunal interchange which is unlikely to be used by most animals, but which will, by chance, be used by some. It requires a major barrier that is occasionally crossed. Which groups cross and when they cross are determined virtually at random.

sweet bay (*Laurus nobilis*) *See Laurus*.

sweet chestnut (*Castanea sativa*) *See Castanea*.

sweet flag (*Acorus calamus*) *See Acorus*.

sweet gum (*Liquidambar styraciflua*) *See Liquidambar*.

sweetlips emperor (*Lethrinus chrysostomus*) *See* Lethrinidae.

sweet potato (*Ipomoea batatas*) *See* Ipomoea.

sweet potato weevil (*Cyclas formicarius*) *See* Apionidae.

sweetsop (*Annona squamosa*) *See Annona*.

swell Long-period waves that have built up sufficient energy to move away from the area where wind stresses created them. The waves assume a uniform pattern and move, in trains of equivalent period and height, even through areas where winds are weak or absent.

swellfish *See* Tetraodontidae.

Swietenia (mahogany; family Meliaceae) The true mahoganies, which are deciduous trees with pinnate leaves, and flowers that are functionally unisexual. The fruit is a capsule. They yield valuable timber. There are three poorly defined species, occurring from Mexico to Brazil, and in the Caribbean region.

swiftlet *See Collocalia*.

swift moths *See* Hepialidae.

swifts *See* Apodidae; Apodiformes; *Apus*; *Chaetura*; and *Collocalia*.

swim-bladder (air bladder, gas bladder) In Actinopterygii, a thin-walled, gas-filled sac in the roof of the abdominal cavity, which allows the fish to achieve neutral buoyancy. It may (physostome) or may not (physoclist) be connected with the intestinal tract. The sac evolved from an accessory respiratory organ and retains a respiratory function in some fish (e.g. Lepisosteidae). It is also sometimes used for sound production (e.g. Holocentridae), or sound reception (e.g. Gadidae).

swimmeret In Crustacea, one of the body appendages that are modified to increase their resistance to water, often by the possession of fringed setae, and that are used to propel the animal through the water. In many Crustacea at least some of these appendages have become heavier and adapted for crawling or burrowing.

swimmers' itch *See Lyngbya*.

swimming crabs *See* Portunidae.

swine fever *See* hog cholera.

swine influenza Disease of the respiratory tract in pigs; the mortality rate may be high, especially in young pigs. Swine influenza is caused by an influenza virus; bacteria may cause secondary infections.

swine vesicular disease Disease of pigs in which the symptoms resemble those of foot-and-mouth disease, i.e. fever, and vesicles on feet and snout. It is caused by an enterovirus.

Swintonia (family Anacardiaceae) Genus of trees which have simple leaves and in which the petals enlarge to form wings around the fruit, which is a nut. There are 15 species, occurring from SE Asia to W. Malesia.

swordfish (*Xiphias gladius*) *See* Xiphiidae.

sword sedge (*Lepidosperma gladiatum*) *See Lepidosperma*.

sword-tailed crickets *See* Gryllidae.

swordtails *See* Papilionidae.

sycamore 1 (Europe, *Acer pseudoplatanus*) *See Acer*. 2 (Near East) *See Ficus*. 3 (N. America) *See Platanus*.

Sycettida (class Calcarea, subclass Calcaronea) Order of sponges whose body possesses a sycon or leucon structure.

sycon Applied to the body structure of a poriferan (sponge) if it consists of a single layer of chambers.

Sydney red gum (*Angophora costata*) *See Angophora*.

syenite Coarse-grained, alkali-rich, intermediate rock, with alkali feldspars representing more than 65% of the total feldspars.

Sylvia (Old World warblers; family Sylviidae) Genus of small to medium-sized warblers, most of which have fairly long, white-edged tails. Males are sometimes brightly coloured, and some have black head markings. They inhabit woodland and scrub, feed on insects and berries, and nest in trees and bushes. There are 17 species, many migratory, found in Europe, Africa, and Asia.

Sylviidae (Old World warblers; order Passeriformes) Family of small birds which have brown, grey, or greenish plumage, some having brighter colours. They have fine, pointed bills, medium-length wings with 10 primaries, and fairly short to long tails. They are mainly arboreal and insectivorous, and nest in trees, bushes, reeds, and on the ground. There are about 50 genera, with about 320 species, many migratory, found in Europe, Africa, Asia, Australasia, and Pacific islands.

sylvite Mineral, specific gravity 2.0, hardness 2.0, chemical composition KCl. It occurs in bedded evaporite deposits, but is one of the last to precipitate because of its solubility in water. It is distinguished by its similarity to halite, but with a much more bitter taste. It is colourless to white, but it can occur in shades of blue, yellow, or red, and it has a vitreous lustre. It crystallizes in the cubic system. The crystals are usually cubes, often in combination with octahedra. It is used extensively as a fertilizer.

symbiont Symbiotic organism. *See also* symbiosis.

symbiosis General term describing the situation in which dissimilar organisms live together in close association. As originally defined, the term embraces all types of mutualistic and parasitic relationships. In modern use it is often restricted to mutually beneficial species interactions, i.e. mutualism. *Compare* commensalism; and parasitism.

symbols (meteorol.) The notation for the presentation of synoptic weather elements at selected stations on a weather map.

Symbranchii Alternative, older name for the group of fish placed in the order Synbranchiformes.

Symingtonia (family Hamamelidaceae) Genus of trees which have tri-nerved leaves, and large, adpressed stipules covering the bud. The flowers are held in heads and become woody in the fruit. There are many winged seeds. There are two species, occurring in the Himalayas, and from S. China to W. Malesia.

Symmetrodonta (subclass Theria, infraclass Pantotheria) Extinct order of mammals which lived during the late Jurassic and early Cretaceous, and which may have appeared toward the end of the Triassic, making them among the earliest mammals known. They had molar teeth with three cusps arranged in symmetrical triangles. They were very small and probably they were predators. They are believed to be ancestral to the Metatheria and Eutheria.

symmetry (crystall.) *See* crystal symmetry.

sympatric Applied to species that occupy similar habitats or whose habitats invariably overlap. *Compare* allopatric.

sympatric evolution The development of new taxa from the ancestral taxon, within the same geographic range—it is geographically possible for interbreeding to occur between the potential new taxa, but for some reason this does not happen. Because of the difficulty of envisaging what the reasons

might be, few authorities until recently accepted the reality of sympatric evolution, except for certain special kinds of organisms; but recent studies have shown that chromosomal mutation can set up a partial barrier to interbreeding sufficient to permit sympatric speciation.

sympatry The occurrence of species together in the same area. The differences between closely related species usually increase (diverge) when they occur together, in a process called character displacement, which may be morphological or ecological. *Compare* allopatry.

Sympetrum striolatum (common darter; order Odonata, suborder Anisoptera, family Libellulidae) Species of small, delicate dragonflies in which the males have a red abdomen and brown thorax, and the females are more soberly coloured, with a sandy abdomen and thorax. Males often settle on bare ground from where they will make rapid, darting flights. This species often flies later in the year than any other. It occurs in Europe and parts of the Middle East.

Symphypleona *See* Collembola.

Symphysodon (discusfish) *See* Cichlidae.

Symphyta (sawflies, woodwasps; subclass Pterygota, order Hymenoptera) The smaller suborder of the Hymenoptera, whose members are distinguished from the Apocrita by the lack of a constriction at the base of the abdomen. The ovipositor is large and used for piercing and sawing plant tissues. Adults have a forewing with 1–3 marginal cells and a hindwing with three basal cells. In adult sawflies, the trochanters (the short segment of the leg between the coxa and femur) are two-segmented. The larvae resemble the caterpillars of the Lepidoptera, but differ in having up to seven pairs of abdominal prolegs. The larvae are mostly herbivorous, except for members of the parasitic family Orussidae. Symphytans occur on flowers and in association with their host plants, some causing defoliation.

symplast The continuum of cytoplasm through a plant that results from the cytoplasm in different cells being connected by plasmodesmata, forming an important pathway, e.g. for auxins.

symplesiomorph Applied to a character state, primitive (plesiomorph) and shared between two or more taxa. Shared possession of a symplesiomorph character state is not evidence that the taxa in question are related.

sympodial Applied to a type of branching in which an apparent main axis is made up of many lateral branches, each arising from the one before, i.e. each is an extension growth from lateral axes, not from the original tip.

Synallaxis (spinetails; family Furnariidae) Genus of mainly brown and rufous birds with medium to long, graduated tails which have projecting shafts. They inhabit forests, bushes, and scrub; feed on insects; and build domed nests with an entrance tunnel. There are about 30 species, found in C. and S. America.

Synanceiidae (stone fish; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Small family of marine fish which have a relatively short, thickset body, and smooth skin covered with many wart-like projections. The large mouth is orientated obliquely, and the small eyes are located near the top of the head. Using the large, paddle-shaped, pectoral fins, the stone fish can partially bury itself and await the arrival of unsuspecting prey animals. The strong, dorsal fin spines bear venom glands at their bases. Because of this, the sting of the well-camouflaged stone fish *Synanceja trachynis* (46 cm) has proved fatal to persons treading on it accidentally. There are about 20 species, in the Indo-Pacific region.

Synaphobranchidae (cut-throat eel; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of marine fish which have an eel-like body covered with scales, a large mouth, and well-developed pectoral fins, the dorsal and anal fins being confluent with the tail-fin. The gill openings are placed close together on the underside of the throat. Like *Synaphobranchus brachysomus* (Gilbert's synaphobranchid), 73 cm, they tend to be deep-sea fish. There are about 11 species, distributed worldwide.

Synaphobranchus brachysomus (Gilbert's synaphobranchid) *See* Synaphobranchidae.

synapomorphic Applied to apomorphic features possessed by two or more taxa in common. If the two groups share a character state that is not the primitive one, it is plausible that they are related in an evolutionary sense, and only synapomorph character states can be used as evidence that taxa are related. Phylogenetic trees are built up by discovering groups united by synapomorphies.

synapse The junction between two neurons. The passage of an impulse along an axon causes the secretion of a neurotransmitter substance (e.g. acetylcholine or noradrenaline), into a space or cleft between the membrane of the axon and that of a dendrite or cell body of an adjacent neuron. The neurotransmitter diffuses across the cleft where it depolarizes the membrane of the latter, thus initiating within it a new impulse; subsequently it is destroyed by an enzyme.

Synapsida (mammal-like reptiles; class Reptilia) Subclass of reptiles which includes the pelycosaurs and therapsids. The pelycosaurs appeared in the Upper Carboniferous and disappeared in mid-Permian times, displaced by the therapsids to which they had given rise. The therapsids flourished in the latter part of the Permian and in the Triassic, but dwindled to extinction in the early Jurassic. The therapsids are the ancestors of the mammals, and share in common with them a synapsid skull (i.e. a skull with one temporal opening above which the postorbital and squamosal bones meet).

synapsis The side-by-side pairing of homologous chromosomes during the zygotene stage of meiotic prophase.

synapticulae Small rods or bars which connect opposed faces of adjacent septa in corals. They perforate the soft mesenteries between the septa.

synarthrial *See* Bourgueticrinida.

Synbranchidae (swamp eel; class Osteichthyes, subclass Actinopterygii, order Synbranchiformes) Small family of freshwater and brackish-water fish which have a very elongate, eel-like body, small eyes, and little-developed dorsal and anal fins confluent with the tail-fin. Because of the modifications of the gill apparatus, some species, e.g. *Synbranchus bengalensis* (Bengal swamp eel), 53 cm, can utilize atmospheric oxygen when the swamp water is depleted of oxygen. Swamp eels, including *Monopterus alba* (rice eel), 90 cm, are considered valuable food fish in Asia. There are about eight species, distributed in Asia, Africa, and S. America.

Synbranchiformes Order of mostly marine fish which have an eel-like body, a single gill slit, and the dorsal and anal fins confluent with the tail-fin. The pectoral fins are always absent.

Synbranchus bengalensis (Bengal swamp eel) *See* Synbranchidae.

syncarp Compound fruit of two or more fused carpels.

Syncarpia (Australian turpentine; family Myrtaceae) Genus of large forest trees, up to 50 m in height, which often reach massive size. The bark is persistent and fibrous. The leaves are of two forms, like those of *Eucalyptus*. The juvenile leaf is elliptical, pubescent, and short-stalked; the adult leaves are opposite, pedunculate, ovate or elliptical, often grouped to appear as though they were whorled. They are glossy and green on the upper surface, and hairy or pubescent below. The flowers are held in globular heads on a thick stalk with several flowers in the head. The sepals are short and rounded, the four or five petals free. The stamens are long, numerous, and free, often held in two rows. The single style is slender. The capsules are three-celled, hard and woody, with a persistent calyx, and contain many small seeds. The timber is valuable, being heavy, hard, and durable. It is used in construction work. The trees are sometimes planted for shade and as windbreaks. The genus is represented in rain forest and *Eucalyptus* forest in Queensland, most often in the transition between the two. There are four species, all endemic to Queensland.

syncarpous With the carpels concrescent.

Synchytriaceae (order Chytridiales) Family of fungi which live parasitically on plants and in which the entire thallus is involved in the formation of a reproductive structure. The family includes three genera, the largest of which is *Synchytrium*.

Synchytrium (family Synchytriaceae) Genus of fungi which are plant parasites. *S. endobioticum* is an important pathogen of potatoes, causing black wart disease.

synclinal ridge Elongated hill underlain by a syncline whose axis trends in parallel with it. Its upstanding nature may result from the relative strength of a compressed downfold compared with the tension-induced weakness of adjacent anticlines, but other explanations have been proposed. *See also* inverted relief.

syncline Basin or trough-shaped fold whose upper component strata are younger than those below.

syndactylous In Marsupialia, applied to the condition in which the second and third hind digits are united within a common sheath. In birds, applied to feet that have two of the front toes partly joined. The condition is found in Alcedinidae, Coraciidae, Bucerotidae, and *Rupicola* species (cocks-of-the-rock).

synecology The study of whole plant and animal communities, including the study of terrestrial ecosystems, biological aspects of oceanography, and applied problems of human management and alteration of ecosystems. *Compare* autecology.

Synentognathi Alternative, older name for the flying fish and its relatives, now placed in the order Atheriniformes.

synergid (pl. synergidae) One of two haploid cells that lie inside the embryo sac, beside the ovum. Synergidae nourish the ovum.

synergism The result of combined factors, each of which influences a process in the same direction but which, when combined, give a greater effect than they would acting separately.

synform Basin or trough-shaped fold whose younger strata may be above or below older ones.

syngamy The union of nuclei of two gametes to produce a zygote nucleus, following fertilization.

syngeneic *See* isogeneic.

Syngnathidae (sea-horse, pipefish; class Osteichthyes, subclass Actinopterygii, order Syngnathiformes) Large family of mainly marine fish in which the body is encased in a series of bony rings or plates. They can be distinguished by a tube-like snout with a minute mouth at the tip, a single dorsal fin, and no pelvic fins. Such species as *Nerophis ophidion* (straightnosed pipefish), 60 cm, and *Hippocampus hippocampus* (sea-horse), 15 cm, of the E. Atlantic, both of which are usually found among seaweeds, are known to keep their young temporarily in a brood pouch developed by the male. A few, e.g. *Phycodurus eques* (leafy sea-dragon), 30 cm, of S. Australia, form elaborate leaf-like appendages, making it very hard to see the fish when hidden between branches of seaweed. There are about 175 species, distributed worldwide.

Syngnathiformes Order of somewhat peculiar marine fish which have a small, toothless mouth at the end of a tube-like snout. The body is at least partly protected by a number of bony plates or rings, and the fins are generally small. The order includes about six families, e.g. Aulostomidae (trumpetfish) and Syngnathidae (pipefish).

Synhalonia *See* Anthophoridae.

Synlestidae *See* Chlorolestidae.

synnema (mycol.) *See* coremium.

Synodidae Alternative name for the fish family Mochokidae (upside-down catfish).

Synodontidae (lizardfish, grinner; class Osteichthyes, subclass Actinopterygii, order Myctophiformes) Family of marine fish which have a slightly

depressed head, a large mouth with many fine teeth, and a single dorsal and an adipose fin opposite the anal fin. Lizardfish are found in shallow water, sometimes burying themselves in the sand. Although not valued highly as food fish, some species, e.g. the large-scaled *Saurida undosquamis* (grinner), 55 cm, can be used as fish bait. There are about 34 species, distributed worldwide.

synonym Term used in taxonomy, denoting a different name for the same species or variety of organism.

synoptic meteorology The presentation of the current weather elements of an extensive area at a particular time. Sea-level and upper-level synoptic charts display weather conditions by symbols at selected synoptic stations.

Synthemidae (Synthemistidae, dragonflies; order Odonata, suborder Anisoptera) Family of dragonflies which are superficially similar to the Gomphidae. In the wings, the primary antenodals are very distinct, and the median space has cross veins. The nymphs are bottom-dwellers, and resist droughts by burying themselves very deeply. The insects frequent marshy areas, as well as fast-flowing streams. The family occurs throughout the SW Pacific; 31 extant species have been described.

Synthemistidae *See* Synthemidae.

synthetic theory Modern theory of evolution, incorporating Darwinian thinking, Mendelian genetics, and an understanding of genes and genetic change at the molecular level.

syntype All specimens in a type-series in which no holotype was designated.

synusia A distinct layer in an area of vegetation which is composed of plants of a similar life-form, e.g. *Polytrichum* moss on the ground layer of an open oak wood. Different synusiae may appear in the same layer at various seasons of the year.

syphilis Disease of humans caused by *Treponema pallidum*; transmission occurs primarily by sexual contact. The first symptom of infection is the development of a sore (chancre), usually in the genital region; later, secondary lesions develop, and finally the bones, heart, and nervous system may become involved.

Syringa (lilac; family Oleaceae) Genus of shrubs and small trees with simple, oval, opposite leaves, four-lobed corollas, capsular fruits, and winged seeds. The panicles of fragrant, lilac-coloured, white, or purple flowers make this a favourite garden shrub. The name 'syringa' is sometimes applied (quite wrongly) to *Philadelphus* (mock orange), which is not related to lilac.

'syringa' Name used incorrectly for *Philadelphus*.

Syringaxon *See Alleynia*.

Syringocnemida (class Anthocyathea) Order of solitary Lower Cambrian Archaeocyatha. They are conical in shape, and with an outer wall that is simply porous. The inner wall is simply porous or with pore-tubes. The intervallum contains prismatic, porous-walled tubuli, but no septa or tabulae. The order contains two families, with six genera.

Syringopora fischeri One of the last representatives of the stony, colonial corals belonging to the subclass Tabulata, which flourished during the Upper Palaeozoic, and are known from the Upper Permian of Germany. At the end of the Permian both tabulate and rugose corals became extinct.

syrinx The vocal apparatus of a bird.

Syrphidae (hoverflies, sunflies, flower flies, drone flies, sweat flies; class Insecta, order Diptera, suborder Cyclorrapha) One of the largest dipteran families, whose members are quite distinctive. They are moderate to large, often brightly coloured flies, whose most characteristic feature is the presence of a 'false' vein (vena spuria) between R and M. The outer edge of the wing has an inner margin formed by connections between the outer wing veins. The antenna has a dorsal arista in almost all species. Adults may be striped, spotted, or banded with yellow and black, giving them a passing resemblance to wasps. Others are hairy and dark-coloured, and in many respects resemble bees. The name 'hoverfly' refers to their ability to hover in mid-air over a flower or mate. The larvae fall into three broad groups, and may be: (*a*) phytophagous, often feeding on roots, or inside plants; (*b*) carnivorous, perhaps best known as voracious feeders on aphids, for which they are of great economic value, but some species also eat other insect larvae; or (*c*) scavengers and detritus feeders, in mud, hymenopteran nests, or in decaying plant material. More than 5000 species have been described. *See also* venation.

Syrrhaptes (sandgrouse; family Pteroclidae) Genus of sandy brown sandgrouse with elongated central tail feathers, and legs which are completely feathered, including the toes. They inhabit desert and steppe areas, feed on seeds, and nest on the ground. There are two species found in Asia, although *S. paradoxus* (Pallas's sandgrouse) is highly irruptive (prone to mass migrations) and occasionally spreads as far west as Britain.

Syrrhaptes paradoxus (Pallas's sandgrouse) *See Syrrhaptes*.

system (geol.) The chronostratigraphical equivalent of the time unit 'period'.

systematic sample *See* regular sample.

systemic arch In the embryo of a tetrapod, the fourth aortic arch which, in the adult, becomes the main source of the blood supply to all parts of the body other than the head. In amphibians and reptiles both right and left arches are present in adults. In birds only the right arch is present in adults and in mammals only the left arch is present in adults.

Syzygium *See Eugenia*.

syzygy (protozool.) In certain types of protozoa, an association between potential gametocytes, prior to gamete formation, in which fusion of nuclei does not occur.

T

Tabanidae (horse flies, gadflies, stouts, clegs, deerfly, breezes, greenhead; class Insecta, order Diptera, suborder Brachycera) Large family of flies, which are often large, stout, and lack bristles. The third antennal segment is annulated, but without a style. The eyes are very large in relation to the size of the fly, and are extended laterally. The bright, colourful, often iridescent eyes are perhaps the most obvious feature of the adult. The mouthparts have a projecting proboscis which in the female is adapted for piercing. Squamae are large, the pulvilli and arolium pad-like. Adults are active on warm summer days and are rapid and often noisy fliers. They are particularly troublesome to cattle and horses, and may be responsible for the transmission of the disease surra of horses. Eggs are laid in compact masses near the damp soil, mud, or other substrate suitable for larval growth. The larvae are carnivorous, feeding upon other insects. The family is distributed worldwide, and about 2000 species have been described.

Tabasco turtle *See* Dermatemydidae.

Tabulata (subclass Zoantharia) Extinct order of exclusively colonial corals with small corallites, well-developed tabulae, and weak or absent septa, which usually number 12 when present and are developed as a vertical series of spines. They often acted as framework organisms in Palaeozoic reefs. They are widely known from Ordovician to Permian rocks, and are recorded with uncertainty from the Triassic and Eocene. The order contains six families, with 108 genera.

Tacca (family Taccaceae) Genus of rhizomatous herbs in which the leaves are radical, broad, and sometimes divided. The flowers are held in umbels on a long scape, subtended by bracts, the inner ones being long and thread-like. The perianth is united with six lobes; there are six epipetalous stamens; and the ovary is inferior with one locule. The fruit is a many-seeded berry. E. Indian arrowroot comes from the tubers of *T. pinnatifidia*. Hawaiian arrowroot comes from *T. hawaiiensis*. There are 30 species, occurring from W. Africa to the Pacific islands.

Taccaceae Family of tropical, perennial, rhizomatous herbs in which the large, simple or lobed leaves are radical and often on long petioles. The regular, bisexual flowers are held in umbels subtended by long and broad bracts, which often form an involucre below the inflorescence. The sepals and petals are similar, and are held in two series of three segments fused to form a broad, bulbous tube to which the six stamens are attached. The ovary is inferior, of three fused carpels forming a single locule with numerous ovules. The style is short, with three stigmas. The fruit is a berry with many seeds, which have much endosperm. The family is important for the two species that yield from their tubers the edible starch called E. Indian or Hawaiian arrowroot. These are *Tacca pinnatifida* from the E. Indies, and *T. hawaiiensis*. There are two genera, one monotypic, in the family, separated by their leaf and fruit characteristics. There are 31 species, found throughout tropical regions.

Tachinidae (parasitic flies; class Insecta, order Diptera, suborder Cyclorrapha) Large family of true flies whose larvae are parasites of insects and other arthropods. The adults are distinguished by a strong fan of hypopleural bristles, and a well-developed postscutellum. The second abdominal sternite is visible as side plates lying above the tergite. The larvae are unlike other cyclorraphan larvae in being uniformly cylindrical, rather than tapered. There are many larval habits and methods for attacking hosts: (*a*) eggs are laid on the surface of the host; (*b*) eggs are laid in large numbers on potential food plants for the host, and are eaten; (*c*) eggs are laid near the habitat of the host, and hatch into active larvae which seek out a host; and (*d*) larviparous females puncture the skin of the host and deposit an egg which hatches immediately. The usual hosts are larval or adult Coleoptera, Orthoptera, and Hemiptera, occasionally Hymenoptera, but most frequently Lepidoptera. The larvae breathe either by maintaining a connection with the air outside the host, or by tapping the air supply of the host at a tracheal trunk. More than 9000 species have been described, and their distribution is worldwide.

Tachyglossidae (echidna, spiny ant-eater; class Mammalia, subclass Prototheria, order Monotremata) Family of insectivorous monotremes in which the limbs are modified for digging, the body is covered with hair modified except on the belly into barbless spines, the snout is long, and the tongue is long, sticky, and has horny serrations that grind against ridges in the palate. There are no teeth, and the lower jaw is much reduced. They occur only in Australia and New Guinea. There are two species, in two genera, *Tachyglossus* and *Zaglossus*.

Tachysuridae *See* Ariidae.

tachytely Rate of evolution within a group that is much faster than the average, or horotelic, rate. Such accelerated evolution typically occurs when an organism enters a new adaptive zone and initiates an adaptive radiation to fill the available niches.

Tadorna (shelducks; family Anatidae) Genus of fairly large waterfowl which resemble geese and have long necks. Their plumage is mainly white, black, and chestnut-orange in colour, and most species have large areas of white on the wing and a metallic green speculum. Their bills are short and slightly upturned. They inhabit wetlands and grasslands, are omnivorous, and nest in tree holes

and burrows. There are seven species, found in Europe, Africa, Asia, and Australasia. *T. cristata* (crested shelduck) may be close to extinction.

Tadorna cristata (crested shelduck) *See Tadorna*.

tadpole The round-bodied, long-tailed larva of an anuran (class Amphibia). The term is also used for other larvae with this form, e.g. those of sea squirts and salps (sub-phylum Tunicata, phylum Chordata).

tadpole sculpin *See* Psychrolutidae.

tadpole shrimp *See* Notostraca.

Taeniodontia Small mammalian order from the Palaeocene and Eocene of N. America. They were derived from insectivore stock, and some forms resembled heavy dogs with rodent-like gnawing teeth.

Taenioidea *See* Cyclophyllidea.

tafoni Hollow, produced by localized weathering on a steep face. Rock breakdown is typically by granular disintegration or by flaking, and the hollow shows a tendency to grow upwards and backwards.

tagma *See* abdomen.

Tahitian chestnut (*Inocarpus fagiferus*) *See Inocarpus*.

taiga Name applied by many authorities to the whole of the boreal forest, but by some only to the more open, park-like tracts along the northern fringe of the boreal forest, otherwise known as 'lichen woodland'.

tailed frogs *See* Ascaphidae.

tailless whipscorpion *See* Amblypygi.

tailor *See* Pomatomidae.

take-all Disease of wheat, barley, and other grasses, caused by the fungus *Gaeumannomyces graminis*. The pathogen infects the roots of the plant, causing root rot and blackening of the stem base; the ears are bleached and empty ('whiteheads').

tal *See Borassus*.

Talauma (family Magnoliaceae) Genus of trees and shrubs in which the fruiting carpels form a woody or cartilaginous mass, separate from the axis, and dehiscing. There are 40 species, occurring in tropical and subtropical Asia and America.

talc (soapstone, steatite) Secondary mineral, specific gravity 2.6–2.8, hardness 1.0, chemical composition $Mg_2Si_4O_{10}(OH)_3$. It forms as a result of the alteration of olivine, pyroxene, and amphibole, and along faults in magnesium limestone. Massive talc is called steatite or soapstone and often results from the thermal metamorphism of impure dolomitic limestone. It is distinguished by its extreme softness and soapy feel. It is white to very pale green, and has a dull to pearly lustre. It crystallizes in the monoclinic system. Crystals are very rare; talc develops in foliated and granular masses. It is used extensively as a mineral filler.

Talfan disease Disease of pigs, caused by an enterovirus. The disease is a milder form of Teschen disease.

talik *See* permafrost.

talipot palm (*Corypha umbraculifera*) *See Corypha*.

Talitrus (beach hopper) *See* Amphipoda.

tallow beetle *See* Dermestidae.

Talpidae (moles, desmans; order Insectivora, suborder Lipotyphla, superfamily Soricoidea) Family of insectivores that are adapted for burrowing. The eyes are small and in some species covered by skin, and external ears are usually absent. The forelimbs are modified, in the moles for digging, in the desmans for swimming; the digits form shovels or paddles, and can be rotated so that they project at right angles from the body. The upper molar teeth have a W-shaped pattern. The tail is short, and the thick, short fur can lie in any direction. The Talpidae are distributed throughout temperate Europe and Asia, except Ireland and Norway, and in SE Asia, and in eastern and western N. America. There are 12 genera, with about 30 species.

talus 1 (anat.) Astragalus; ankle-bone. *See* tibiale. 2 (geol.) Sloping mass of rock fragments at the foot of a cliff.

Tamaricaceae Family of dicotyledonous trees and shrubs with minute, scale- or needle-like leaves, resembling those of conifers. The tiny, regular flowers, which are tetra- or pentamerous, are normally grouped in dense spikes or racemes. The stamens are usually free, and the ovary is one-celled and superior, ripening to a capsule. Several *Tamarix* species (tamarisks), particularly *T. anglica*, are frequently planted for ornament or shelter, or are naturalized, on the coasts of NW Europe and elsewhere as they survive salt spray and strong winds very well. There are four genera and about 100 species, occurring from SW Europe to SE Asia, and S. Africa.

tamarin (*Saguinus*) *See* Callitrichidae.

tamarind 1 *See Tamarindus*. 2 (native tamarind, *Diploglottis cunninghamii*) *See Diploglottis*.

Tamarindus (tamarind; family Leguminosae, subfamily Caesalpinoideae) Genus of one species, *T. indica*, which is native to tropical Africa and W. Asia, and is now widely cultivated. It is a big, deciduous tree. The leaves are pinnate. The pod is dehiscent, with several seeds set in a pulp which is much valued as a foodstuff and enters world commerce as a basis for sauces.

tamarisk (*Tamarix*) *See* Tamaricaceae.

Tamarix (tamarisk) *See* Tamaricaceae.

Tamias (chipmunk) *See* Sciuridae.

tanagers 1 *See Euphonia*; *Piranga*; *Tangara*; and *Thraupidae*. 2 (swallow-tanager, *Tersina viridis*) *See* Tersinidae.

Tangara (tanagers; family Thraupidae) Genus of small, brightly coloured tanagers, many of which are brilliant blue with black face patches. They inhabit dense forest, feed mainly on fruit, and nest in trees and bushes. There are about 47 species, found in C. and S. America.

tangle Common name for the large brown seaweed *Laminaria digitata*. The holdfast is much branched and root-like, the stipe is thick, flexible, smooth, and cylindrical, and the blade is oar-shaped and divided into many strap-like ribbons. It is found at and below low-water mark.

tannia *See Xanthosoma*.

tannin Generic term for complex non-nitrogenous compounds containing phenols, glycosides, or hydroxy acids, which occur widely in plants. They are toxic substances with astringent properties, whose principal function appears to be to render plant tissues unpalatable to herbivores.

tantalite Mineral, specific gravity 7.5–8.0, hardness 6.0–6.5, and with the chemical composition $(FeMn)(TaNb)_2O_6$. It occurs in granites and pegmatites in association with quartz, feldspar, tourmaline, beryl, spodumene, petalite, cassiterite, wolframite, and columbite. It is distinguished by its crystal form, black colour, weak magnetic properties, and high specific gravity. It is iron-black, and has a red-black streak, and a sub-metallic lustre. It crystallizes in the orthorhombic system. The crystals are normally thick, tabular, and prismatic in shape, but they can also be massive. It is an ore mineral for tantalum metal.

tapaculos *See* Rhinocryptidae; and *Scytalopus*.

tapeworms *See* Cestoda.

Taphrinales (class Hemiascomycetes) Order of fungi, which are parasitic on a range of flowering plants and ferns. There is one family, containing a single genus, *Taphrina*. There are nearly 100 species of *Taphrina*, including the agent responsible for peach leaf-curl (*T. deformans*) and other diseases involving leaf distortion.

tapir (*Tapirus*) *See* Tapiridae.

Tapiridae (tapirs; order Perissodactyla, suborder Ceratomorpha, superfamily Tapiroidea) Family of solitary, nocturnal ceratomorphs which are little different from the perissodactyl stock that lived during the late Eocene and Oligocene. Many tapir-like forms are known from the Eocene, and are sometimes grouped as Lophiodontidae. The limbs are short, with three digits on the hind feet and four on the forefeet. The digits bear small hoofs, but the soles of the feet also have thick pads. The ulna and fibula are complete and unfused. The teeth are complete in number, low-crowned, and lack cement except for the first three premolars. The nose has developed into a short, mobile trunk, with an associated shortening of the nasal bones. Tapirs live mainly in dense forest, feeding on fruit and vegetation, in tropical C. and S. America, and in SE Asia. There are four species, in one genus, *Tapirus*.

Tapiroidea (superorder Mesaxonia, order Perissodactyla, suborder Ceratomorpha) Superfamily comprising the family Tapiridae together with a number of ceratomorphs known from the Eocene and Oligocene and arranged in several small families. Many of these families constituted evolutionary branches from the lines leading to the modern ceratomorphs, but some were ancestral to *Protapirus*, a true tapir which lived in the Oligocene; and *Hyrachyus* was one of several Eocene forms that may be ancestral to rhinoceroses.

tap root Large, descending, central root.

tapu cloth *See Broussonetia*.

tarantula (order Araneae, suborder Mygalomorphae) The common name given to most large spiders belonging to the Mygalomorphae. Many have hairs which produce an *Urtica*-like rash. Some species are venomous, but are less dangerous than is generally supposed, inflicting bites that in humans are no worse than wasp stings.

Tarbosaurus bataar Carnivorous dinosaur very similar in size and form to *Tyrannosaurus*, and one of the largest meat-eating animals ever to have lived on Earth. Individuals from the Late Cretaceous of Mongolia reached almost 12 m in length and weighed approximately seven tonnes.

tarn Small mountain lake that forms in a cirque.

taro (*Colocasia esculenta*) *See Colocasia*; *compare* giant taro; and giant swamp taro.

Tarphyceratida (class Cephalopoda, subclass Nautiloidea) Relatively small order of evolute, coiled cephalopods in which the position of the siphuncle is variable, generally depending on the maturity of the individual. Septa are simple. The order is most important in the Lower Ordovician, and dies out in the Upper Silurian.

Tarpon atlanticus (tarpon) *See* Megalopidae.

tarsal bone In tetrapod vertebrates, one of the distal bones of the hind foot that articulate with the digits (metatarsals).

tarsal claw Claw carried on the final tarsal segment of an insect. There may be more than one claw on each tarsus.

tarsiers (*Tarsius*) *See* Tarsiidae.

Tarsiidae (tarsiers; order Primates, suborder Haplorhini, infra-order Tarsiiformes) Family of arboreal, nocturnal, insectivorous or carnivorous primates, about the size of rats, in which the upper lip is whole, there is no moist rhinarium, and the hind legs are very long and used in leaping from tree to tree. The tibia and fibula are fused and the calcaneum and astralagus elongated, but the feet retain their grasping digits. The hallux and pollex are opposable, all digits end in adhesive pads, and apart from the second and third hind digits, which have claws, all digits bear flattened nails. The tail is long. The snout is shortened; the face is sufficiently mobile for it to be used to express emotion; the eyes face forward and are extremely large; and the head is mounted on a neck so mobile that the animal can face directly backwards. The ears are large and mobile, and the sense of hearing is acute. The placenta resembles that of the higher primates, but the uterus that of lemurs. Tarsiers occur only in parts of Indonesia, E. Malaysia, and the Philippines. There are three species, in a single genus, *Tarsius*.

Tarsiiformes (order Primates, suborder Haplorhini) Infra-order, regarded by some authorities as

a suborder (Tarsii or Tarsioidea), comprising the families Omomyidae, of extinct tarsier-like primates which lived during the Eocene and Oligocene, some surviving into the Miocene in northern continents, and Tarsiidae, the modern tarsiers and their immediate ancestors. In some classifications the tarsioids are included as a group of a larger suborder, the Haplorhini, which also includes the Anthropoidea.

Tarsioidea *See* Tarsiiformes.

Tarsius (tarsier) *See* Tarsiidae.

tar spot Disease of sycamore (*Acer pseudoplatanus*) in which black spots appear on the leaves due to infection by *Rhytisma acerinum*. The name may also refer to the fungus itself.

tarsus 1 In an insect, one of a number of small segments distal to the tibia, with which the uppermost tarsus articulates. The tarsus is made up of 2–5 segments and terminates in the pretarsus. The muscles operating the tarsi are located in the tibia, and operate through the agency of tendons. 2 In Aves, the lower long bone of the leg. 3 In Mammalia, the collection of bones forming the ankle. 4 In vertebrates, a plate of connective tissue in the eyelid.

Tasmanian devil (*Sarcophilus harrisi*) *See* Dasyuridae.

Tasmanian 'wolf' (*Thylacinus cynocephalus*) *See* Thylacinidae.

Tauraco (touracos; family Musophagidae) Genus of bright green touracos which have black, blue, or green, glossed tails. They have bare areas of red or yellow skin around the eye, and coloured crests. Their flight feathers are crimson. They inhabit forest areas, feed on fruit, and nest in trees. There are about 15 species, found in Africa.

Taurotragus oryx (eland) *See* Bovidae.

tawny cockroach (*Ectobius lapponicus*) *See Ectobius*.

tawny mining bee *See Andrena fulva*.

Taxaceae Family of mostly dioecious conifers with the ovules solitary or in pairs and not borne in cones, but surrounded when ripe by a fleshy sheath or aril, which is often coloured and resembles a berry. This is always open at the tip exposing the pollination pore, or micropyle, of the ovule. The male flowers are borne in tiny globular cones; the pollen grains are unwinged; and no resin cells or canals occur in the wood. There are five genera, including *Taxus* (yew), in the northern temperate zone and in New Caledonia.

Taxales Order of the Gymnospermae, and the youngest in the subdivision Coniferopsida, dating from late Cretaceous times.

Taxidea (badger) *See* Mustelidae.

taxis 1 (ethol.) Movement of an animal in a particular direction in response to a stimulus. 2 (microbiol.) Change in direction of locomotion in a motile micro-organism or cell, made in response to certain types of external stimulus, e.g. the presence of particular chemicals (chemotaxis), changes in light intensity (phototaxis), or changes in temperature (thermotaxis), etc.

Taxodiaceae Family (or according to some authors, tribe of the family Pinaceae) of conifers. The leaves are spirally arranged (not in opposite pairs as in Cupressaceae) and the leaves are evergreen, hard, and scale-, spine-, or awl-like in most genera, though in a few genera (e.g. *Metasequoia and Taxodium*) they are soft and deciduous . The cones are globular and hard with the bracts completely fused to the ovule-bearing scales (as in Cupressaceae but unlike Pinaceae). The family consists of ten genera, nearly all of only one species each. It includes many ancient relict monotypic genera, like *Sequoiadendron*, *Sequoia*, *Metasequoia*, and *Cryptomeria*, all of extremely limited distribution as natives today though formerly mostly very widespread (epibiotics), but widely cultivated in many temperate regions: for example, *Sequoiadendron giganteum* (Wellingtonia or big tree), once widespread in the world in Pliocene times, is now confined as a native to the Sierra Nevada of California; *Metasequoia glyptostroboides* (dawn redwood), which was thought to have died out in the Pliocene and was described as a fossil in 1941, was found to be surviving in central China in 1945.

Taxodium (swamp cypress; family Taxodiaceae) Genus of conifers with alternate, strap-shaped deciduous leaves, and remarkable 'knees' on its roots in wet soil, which come to the surface like the pneumatophores of mangroves, and evidently help to provide oxygen for the root system. There is one species, *T. distichum*, confined to the USA and Mexico.

Taxodium distichum (swamp cypress) *See Taxodium*.

taxodont Applied to a primitive type of hinge dentition, present in certain pelecypods, in which teeth and sockets are small and numerous. They are arranged in a row on each side of the beak, on both valves.

taxon (pl. taxa) Group of organisms of any taxonomic rank, e.g. family, genus, or species.

taxonomy The scientific classification of organisms.

Taxus (yew; family Taxaceae) Genus of conifers with erect, solitary ovules surrounded by fleshy cup-like red arils with a sweet taste. The whole plants are highly poisonous (containing the alkaloid taxine) except for the red arils of the seeds. *T. baccata* is native in western Europe and is notable for its longevity; some specimens planted in churchyards in Britain and in France are believed to be about 1000 years old. It is the only genus of the family in Europe. There are six or seven species, distributed through the northern temperate zone.

Taxus baccata *See Taxus*.

Tayassuidae (peccaries; order Artiodactyla, suborder Suiformes) Family of omnivorous animals, which are related to pigs, but evolutionarily distinct from them for much of the Tertiary. The oldest

fossil peccary comes from the Oligocene of N. America. The upper canines form sharp tusks which grow downward, the molars are simpler than those of pigs, and the radius and ulna are fused. There is a scent gland at the centre of the back. Probably peccaries lived in both Old and New Worlds until the Miocene; one survived until the Pliocene in S. Africa. During the Pleistocene they were distributed widely in temperate N. America. They reached S. America during the Pliocene and today they occur throughout most of S. America and as far north as Texas. There are three species, in two genera: *Tayassu*, containing *T. tajacu* (the collared peccary) and *T. pecari* (the white-lipped peccary), and *Catagonus*, containing one living species, *C. wagneri* (the Chacoan peccary), known since 1930 as a subfossil but in 1972 discovered to be still living in the Chaco, on the Paraguay–Argentina–Bolivia border.

TB *See* tuberculosis.

Tchagra (bush-shrikes; family Laniidae) Genus of shrikes which have fairly strong, hooked bills. They are mainly brown, with rufous wings, and the tail is tipped white, with white outer feathers. Most have black or brown caps, with a dark eye stripe. They inhabit open areas and forest edges, feed on insects, reptiles, and other animals, and often hunt on the ground by running. Their nests are built in bushes and trees. There are six species, found in Africa.

T_e *See* effective temperature.

tea (*Camellia sinensis*) *See Camellia*; and Theaceae.

teak (*Tectona grandis*) *See Tectona*; and Verbenaceae.

tea-tree *See Leptospermum*.

Tecoma (family Bignoniaceae) Genus of woody climbers which have pinnate leaves and colourful trumpet-flowers. Several are grown as ornamentals. There are 16 species, occurring from Florida to Argentina.

Tectona (family Verbenaceae) Genus of deciduous trees which have big, opposite leaves. The flowers are small and held in big terminal panicles. The fruit is surrounded by the inflated calyx. *T. grandis* (teak) is the commonest and most wide-ranging species, much cultivated for its durable, attractive timber. There are three species, occurring in seasonal SE Asia.

tectonism Deformation within the Earth's crust, and its consequent structural effects.

Tegenaria gigantea (common house spider; suborder Araneomorphae, family Agelenidae) Species of spider in which females are up to 18 mm long and males up to 14 mm; it is found in houses and gardens, but also under logs and in holes in banks. The carapace is brown, with two rows of radiating dark markings and a dark margin. The abdomen is yellow-brown to reddish-brown with black areas. This species is commonly found in autumn, and the webs it spins are small. Capable of surviving long periods without food, the females are long-lived and can be found throughout the year. It is common throughout Europe, including Britain.

tegmen *See* Acrididae; Camerata; and Homoptera.

tegu *See Tupinambis teguixin*.

tegula (pl. tegulae) Small cuticular plate at the base of the wings of an insect, which is derived from the edge of the articular membrane.

tegulicolous Growing on tiles, e.g. on a roof.

Teiidae (tegus, whiptails; order Squamata, suborder Sauria (Lacertilia)) Family of lizards, which differ from the Lacertidae in having head plates that are separate from the skull bones. The tongue is long and forked. The tail is long, and the limbs may be large and powerful, or reduced (e.g. in snake and worm teiids). There are more than 200 species. They are the New World counterparts of the Lacertidae. *See also Tupinambis teguixin*.

tektite Small, glassy body which is considered to be of extraterrestrial origin.

Telcanthura *See Chaetura*.

Teleostei (teleost, teleostean) Somewhat loosely defined term (an infraclass according to some authors) that includes all the bony fish (Osteichthyes) with the exception of a few orders of primitive fish (Acipenseriformes, Amiiformes, Semiodontiformes, and their fossil relatives).

Teleostomi The 'true' fish (Osteichthyes), i.e. those with a terminal mouth, in contrast to the shark-like fish (Chondrichthyes) which have the mouth positioned underneath a substantial rostrum. Some authors consider the (subgrade) Teleostomi to include the class Osteichthyes as well as the class of fossil Acanthodii. *See also* bony fish.

Telestacea (subclass Octocorallia) Extant order of corals with simple or branched stems arising from a creeping stolon base; elongate polyps are produced from the body wall of the primary polyp; numerous sclerites may be free or varyingly fused together. They are found from the low-tide line to depths of 765 m.

teleutosorus *See* telium.

teleutospore *See* teliospore.

Teliomycetes (subdivision Basidiomycotina) Class of fungi which do not form basidiocarps. All members are obligately parasitic on plants. There are two orders. The class includes many important plant pathogens.

teliospore (teleutospore) Resting spore formed by fungi of the Uredinales and Ustilaginales. Germination of a teliospore results in a promycelium (basidium) from which develop basidiospores.

telium (teleutosorus) Region of spore-bearing fungal tissue in a host plant infected with a rust fungus. Telia vary in structure among the various species of rust. The spores produced in a telium are called teliospores.

telocentric chromosome Chromosome the centromere of which is at one end.

Telopea (family Proteaceae) Genus of tall shrubs, with alternate, often leathery leaves which are entire or toothed, with or without stipules. The

flowers are irregular, bisexual, and held in pairs. They are showy, red, and composed of four perianth lobes with reflexed tips. Two to four scales, like petals, alternate with the lobes. The four stamens are attached to the lobes. The ovary is superior, with a single carpel and four ovules in the single locule. The fruit is a hard, sessile follicle with single-winged seeds. There are four species, endemic to E. Australia and Tasmania.

telophase The fourth and final phase of mitosis and meiosis, during which the spindle disappears, nucleoli reappear, the nuclear membranes start to develop around the two groups of daughter chromosomes/chromatids, and the chromosomes return to their extended state in which they are no longer visible. The nuclei then enter a resting stage as they were before division occurred.

Teloschistaceae (order Lecanorales) Family of lichens in which the thallus may be crustose, foliose, or fruticose, and typically is yellow, orange, or red. There are several genera, found mostly in nitrogen-rich habitats, particularly in warm, dry regions.

Telosporea (subphylum Sporozoa) Class of parasitic protozoa, most of which live inside the cells of their hosts. They may be motile by flexing the cell body or by gliding. Some can complete their life cycle in a single host; others require more than one host species.

telotaxis Movement of an animal possessing sense organs in response to a stimulus. The possession of sense organs enables the animal to determine the source of the stimulus by direct observation.

telson In Arthropoda, the final abdominal segment, present only in the embryo of insects.

Temminck's stint *See* polyandry.

Temnocephala (Temnocephalida; class Turbellaria, subclass Neoophora) Order of platyhelminth worms which have a pharynx and a bag-shaped intestine. The epidermis may be ciliated. They have a non-parasitic mode of life, living on the exterior of freshwater animals.

Temnocephalida *See* Temnocephala.

Temnopleuroida (superorder Echinacea) Order of regular echinoids, having a test sculptured with ridges and/or depressions along the plate sutures, or very deep and conspicuous gill slits. They first appeared in the Lower Jurassic.

temperate climate General term applied to the characteristics of mid-latitude climates influenced from time to time by both tropical and polar air masses. Temperature criteria provide subdivisions into warm-, cool-, or cold-temperate climates. *See also* climate classification; Köppen climate classification; and Strahler climate classification.

temperate deciduous forest Deciduous summer forest dominated by broad-leaved hardwoods, which occurs over large tracts in the mid-latitudes of Europe, N. America, and E. Asia, but which is restricted in the southern hemisphere to Chilean Patagonia. Much of the original forest has been cleared for cultivation and pasture.

temperate glacier Glacier whose temperature throughout is close to pressure-melting point (the melting point is lower when ice is under pressure), except for the winter, when the upper metre or so may be colder. Water is consequently available throughout most of the ice mass and basal sliding is an important mode of movement. The glaciers of Scandinavia and of the Alps are of this type.

temperate grassland Type of vegetation which includes in the northern hemisphere the N. American prairies and the Eurasian steppe, and in the southern hemisphere the veld of S. Africa, the pampas of Argentina, the Canterbury Plains of New Zealand, as well as extensive areas in Australia. Much of this grassland has been ploughed up or converted into pasture for domesticated animals. Although most of this grassland occurs in parts of the temperate zone where there is a seasonal deficit of moisture, there is often enough to permit tree growth. Presumably fires, both natural and anthropogenic, have been important in the development of this grassland.

temperate phage *See* plaque; and virulent phage.

temperature inversion Atmospheric condition in which the typical lapse rate is reversed and temperature increases vertically through a given layer. In the troposphere an inversion layer marks conditions of great stability, i.e. a region in which vertical motion is strongly damped, with an absence of turbulence. An inversion acts as a ceiling, preventing further upward convection, and is generally the limit for cloud development. Marked and persistent inversions occur at lower levels, with subsiding air in major anticyclonic cells, such as the Azores high-pressure zone and cold anticyclones over continents. *See also* atmospheric structure; and environmental lapse rate.

temperature range Extent of diurnal or seasonal (annual) temperature variation. Generally the highest annual range of temperature is experienced in higher latitudes, especially over 65 °N, which reflects the continental influences of N. America and Asia. Tropical land masses tend to have the highest diurnal temperature ranges, which in the equatorial zone are much higher than the annual variations. Annual temperature ranges in general are particularly moderated by maritime influences.

temperature-sensitive organ (pit organ) Apparatus, developed in some snakes, that can detect heat radiated from prey and air motion. Paired organs lie in front of the eye in pit vipers (Crotalidae), and lip pits of some boids (Boidae) perform the same function.

temple tree (frangipani) *See Plumeria*.

temporal fossa In the skull of mammals, a cavity behind the orbit, containing muscles involved in the raising of the lower jaw.

tench (*Tinca tinca*) *See* Cyprinidae.

tendency The degree of behavioural motivation that may be inferred from observed behaviour.

tendril Part of a stem, leaf, or petiole that is modified as a delicate, commonly twisted, thread-

like appendage. It is an aid to climbing, as in Cucurbitaceae.

tendrillate With tendrils.

Tenebrio molitor (meal-worm) *See* Tenebrionidae.

Tenebrionidae (darkling beetles, pincate beetles, nocturnal ground beetles; class Insecta, order Coleoptera) Family of beetles which occur as adults in a great variety of sizes and shapes. Many are flightless, with vestigial wings, and fused elytra, which are usually brown to black. They are adapted to living in very dry conditions; some are highly specialized desert species. A number contain blistering chemicals which they spray on attackers. Larvae are long and cylindrical, the body covered with toughened plates. Several are pests of stored products (e.g. *Tenebrio molitor* larvae—meal-worms—which feed on flour). *Blaps mucronata* (black beetle) is often found moving clumsily about cellars and outhouses. There are 15 000 species.

tenrec *See* Tenrecidae.

Tenrecidae (otter shrew, tenrec; order Insectivora, suborder Lipotyphla, superfamily Soricoidea) Family of insectivores in which a cloaca is present, and in which the cusps of the molar teeth form a triangular V-shape, except in the Potamogalinae where they form a W-shape. The Tenrecidae have undergone adaptive radiation to produce forms resembling shrews, moles, and hedgehogs, and *Potamogale* (otter shrew) is an aquatic form closely resembling true otters. Some are larger than most insectivores, one of the tenrecs attaining a length of 50 cm and *P. velox* (giant otter shrew) 60 cm. The Tenrecidae occur only in W. and C. Africa (Potamogalinae) and Madagascar (Tenrecinae). There are 11 genera, with 33 species.

tentacle 1 In many invertebrate animals, a long, slender, flexible structure, often bearing sense receptors, used to obtain information about the immediate environment and often to obtain food. 2 In corals, zoanthids, and anemones, a movable, tubular extension of the body cavity; tentacles are arranged in a ring around the mouth. 3 In cephalopods, a movable modification of the soft body; tentacles surround the mouth and are sometimes studded with sucker discs.

Tentaculata (Micropharyngea; phylum Ctenophora) Class of ctenophorids which have tentacles. There are four orders.

Tentaculitida (phylum Mollusca, class Cricoconarida) Order of thick- or thin-walled cricoconarids, up to 80 mm long, in which the embryonic chamber is conical, with a bluntly pointed apex. the shell is composed of 2–5 layers, with a septate juvenile portion. Transverse rings are present externally, longitudinal striae are rare. The class ranges in age from Lower Ordovician to Upper Devonian.

tentaculocyst In some Coelenterata, a sensory organ concerned with orientation, consisting of a minute tentacle in a pit, the pressure of the tentacle on the sides of the pit stimulating sensors.

Tenthredinidae (sawflies; suborder Symphyta, superfamily Tenthredinoidea) One of the largest families of symphytans, most of which are small, varying in length from 5 mm to about 20 mm. Adults have nine-segmented, thread-like antennae, and are black, brown, or brightly patterned, and can be found on flowers or other vegetation. The larvae of most species are external feeders, but some are leaf-miners or gall-makers. Eggs are inserted by the saw-like ovipositor into leaf tissue or woody twigs, some species causing considerable damage to cultivated plants and forest trees. The well-developed abdominal prolegs common in the symphytans are reduced or absent in leaf-mining or stem-boring species. Pupation generally takes place in the soil within a silken cocoon.

Tenthredinoidea (sawflies; order Hymenoptera, suborder Symphyta) Superfamily of insects, most of which belong to the family Tenthredinidae, whose common name refers to the saw-like ovipositors of the females. They feed on most cultivated plants of economic importance, with species specific for apple, pear, rose, pine, larch, gooseberry, turnip, etc. Some are gall-formers and stem-borers.

tepal One of the perianth members in those flowers where there is no distinction between calyx and corolla.

tephigram Diagram showing the vertical variation in properties of the atmosphere, i.e. temperature and humidity are plotted as a function of pressure, with lines indicating dry and saturated adiabatic lapse rates. The changes in temperature and humidity of lifted air parcels can be compared against the environment (surrounding air) curve revealing the stability or instability of the air mass and the level at which condensation will occur in the uplifted air. *See also* dry adiabatic lapse rate; environmental lapse rate; and saturated adiabatic lapse rate.

tephra Collective term applied to all particles or fragments ejected from a volcano, irrespective of size, shape, or composition.

Tephrosia (family Leguminosae) Genus of shrubs and herbs, which have pinnate leaves, usually with several leaflets but sometimes with very few. The leaves are often silky below. The inflorescence is a terminal raceme held opposite the leaf, or an axillary raceme. The irregular flowers are red, purple, or white, with the calyx teeth about equal in length. The petals are clawed, with the upright petal hairy on its outer surface, and the wing petals held obliquely, often slightly adherent to the incurved keel. The upper stamen is usually free, the remaining nine being fused in a tube. The ovary contains many ovules. There are more than 300 species, found in tropical and subtropical regions of the world, but especially in Africa and Australia.

teratogenic Applied to any substance that interferes with the normal development of a foetus or embryo.

Teratornis incredibilis Condor-like vulture from the Pleistocene of San Diego Co., California, which was the largest known bird ever to have lived on Earth. Individuals with a wingspan of more than

4 m have been recovered from the Rancho La Brea tar pits of California.

Teratosaurus suevicus Animal thought to be the first representative of the tyrannosaur group of giant, meat-eating dinosaurs, recorded from the Upper Triassic of Germany.

Terebrantia *See* Thysanoptera.

Terebratellacea (suborder Terebratellidina) Extant superfamily of Brachiopoda containing six families whose members are characterized by long, complex, or recurved calcareous loops. They appeared first in the Upper Triassic.

Terebratellidina (order Terebratulida) Suborder of Brachiopoda whose members have a calcareous loop formed by outgrowth from both the crura and the median septum. They appeared first in the Devonian; only one of the three superfamilies comprising the suborder is extant.

Terebratulacea (suborder Terebratulidina) Extant superfamily of Brachiopoda, whose members lack dental and septal plates. The superfamily contains eight families, with about 90 genera. They appeared first in the Upper Triassic.

Terebratulida (class Articulata) Order of Brachiopoda with punctate shells, rounded hinge-lines, functional pedicle, deltidial plates, and a lophophore support usually consisting of a pair of crura and a calcareous loop. The three suborders comprising the order first appeared in the Lower Devonian; one became extinct at the end of the Permian, two are extant.

Terebratulidina (order Terebratulida) Suborder of Brachiopoda whose members are characterized by a primitive, short, calcareous loop growing out from the crura. The suborder contains two superfamilies, with 13 families.

terentang The pale, attractively figured timber of *Campnosperma*.

terete Circular in cross-section, used of a plant stem, for example.

tergite In an insect, the dorsal region of a segment of the body, if this region is composed of sclerotized cuticle. If it is not of sclerotized cuticle the region is termed a tergum.

tergum In Arthropoda, a thickened plate on the dorsal side of a segment. *Compare* tergite.

Terminalia (family Combretaceae) Genus of large, deciduous or semi-deciduous trees, which have a distinctive, tiered branching, and the leaves held in terminal clusters. The flowers are held in panicles or spikes, and are apetalous, with 10 stamens, and a disc present. The fruits are woody, and sometimes winged. The trees yield useful timber, and some are used for dyeing and tanning (myrobalans). There are 200 species, occurring throughout the tropics.

terminal moraine *See* moraine.

termitaria *See* Isoptera.

termite *See* Isoptera; and *Trichonympha*.

Termitidae (order Isoptera) Diverse family of 'higher' termites which rely on symbiotic bacteria rather than protozoa (as in all other termite families, the 'lower' termites) for the digestion of cellulose. Members of the African subfamily Macrotermitinae have an additional food source: a basidiomycete fungus which is cultivated on faecal pellets deposited in fungus gardens. Most Termitidae inhabit soil nests. The complex architecture of the large mounds of the Macrotermitinae ensures ventilation and regulation of the microclimate of the nest. There are five families, with about 1500 species, occurring worldwide but mainly in the tropics.

termitophile Applied to a species that must spend part of its life closely associated with termites. It may scavenge or steal food, or may prey on the termites.

ternary fission Type of cell division that results in the formation of three daughter cells from a single parent cell.

ternate Compound and divided into three more or less equal parts.

terns *See* Charadriiformes; Laridae; and *Sterna*.

Ternstroemiaceae The old name for the family Theaceae.

terpene Name given to hydrocarbons that are composed of two or more isoprene units. They may be linear or cyclic molecules or combinations of both, and include important biological compounds such as vitamins A, E, and K, carotenoids, phytol, gibberellic acid, natural rubber, and some lipids.

terrace A nearly flat portion of a landscape, terminated by a steep edge. It may be produced by any one of a range of processes, so the following varieties are recognized: altiplanation terrace, kame terrace, marine terrace, river terrace, and solifluction terrace.

terracette Small-scale landform consisting of a long, narrow, stepped feature developed in unconsolidated material mantling a steep hillslope. It may result from slight slippage in material standing at an angle too great for stability.

Terrapene carolina (Carolina box turtle, eastern box turtle; order Chelonia (Testudines), suborder Cryptodira, family Emydidae) One of the few land-living, emydid turtles, *T. carolina* possesses a hinged plastron that enables the shell to be closed. It is omnivorous, and occurs in the eastern USA.

terrapins 1 *See* Emydidae. 2 (European pond terrapin) *See Emys orbicularis*. 3 (Carolina box turtle) *See Terrapene carolina*.

terra rossa European soils, red in colour, that developed over limestone. They are deep and ancient, some of them being pre-Pleistocene. The USDA Soil Taxonomy classifies them as Inceptisols or Mollisols.

terrestrial radiation Long-wave electromagnetic radiation (wavelengths 4–100 μm, with a peak at 10 μm) from the Earth's surface and atmosphere. *See also* atmospheric 'window'; greenhouse effect; radiation budget; and radiation night.

terricolous Growing on soil or on the ground.

terrier Record of land held and its occupation or use.

territoriality The establishment, demarcation, and defence of an area by animals, normally during mating ritual. Once territory has been established the animals can exist without disturbance and with sufficient food for the offspring. Evidence shows that among territorial species individuals without a territory rarely breed.

territory Area occupied by an animal, or by a pair or group of animals, and defended against intruders.

Tersinidae (swallow-tanager; order Passeriformes) Monotypic family comprising *Tersina viridis*, the male of which is turquoise-blue with a black face and throat, white under-parts, and flanks barred with black. The female is green with yellow under-parts, and flanks barred with olive. The swallow-tanager has a short bill, long wings, and short legs. It inhabits forest, feeds on fruit and insects, and nests in holes in banks and trees. It is found in C. and S. America.

Tertiary First period of the Cenozoic Era, which began 65 million years ago and lasted approximately 63.2 million years. The Tertiary followed the Cretaceous and comprises five epochs: the Palaeocene, the Eocene, the Oligocene, the Miocene, and the Pliocene.

Teschen disease Disease of pigs, first observed in Teschen, a region of Czechoslovakia. Symptoms include fever, convulsions, and paralysis; the mortality rate is often high. It is caused by an enterovirus.

tessellated snake *See Natrix tessellata*.

test Protective shell that covers the cells of certain protozoa and the bodies of certain invertebrate animals.

testa The seed coat. *See* integument.

Testacida *See* Arcellinida.

testate Having a shell or test.

testosterone Steroid hormone, secreted by the testis, that in mammals and birds is the principal male sex hormone, responsible for the development of secondary sexual characteristics.

Testudinidae (land tortoises; order Chelonia (Testudines), suborder Cryptodira) Chelonian family whose members have a high-domed carapace, usually pillar-like legs, and blunt, heavily-scaled, clawed feet. They are primarily herbivorous. There are about 50 species, distributed in varied habitats throughout warmer parts of the world except Australia. *See Testudo elephantropus*; *Testudo gigantea*; *Testudo graeca*; *Testudo hermanni*; *Gopherus polyphemus*; and *Malacochersus tornieri*.

Testudo elephantropus (Galápagos giant tortoise; order Chelonia (Testudines), suborder Cryptodira, family Testudinidae) Large, dark-coloured tortoise, which has a long neck, a carapace up to 1.5 m long, and a maximum weight of about 270 kg. There were once 14 subspecies (differing in shell shape) on the Galápagos Islands, but many have been exterminated due to the activities of humans.

Testudo gigantea (Seychelles giant tortoise; order Chelonia (Testudines), suborder Cryptodira, family Testudinidae) Tortoise which may attain even larger size than the Galápagos giant tortoises (*T. elephantropus*), but which is similar to them in colour and general form. It is distinguished by the median cervical plate on the anterior carapace margin, present only in the Seychelles species. It is now common only on Aldabra.

Testudo graeca (spur-thighed tortoise; order Chelonia (Testudines), family Testudinidae) Tortoise which has a horny tubercle at the rear of each thigh (there is no spur on the tail). It is predominantly herbivorous. It occurs in dry Mediterranean regions, and also Iran. Many populations have been reduced as a result of supplying tortoises to the pet trade.

Testudo hermanni (Greek tortoise, Hermann's tortoise; order Chelonia (Testudines), family Testudinidae) Tortoise which has a horny spur on the end of its tail. It is predominantly herbivorous. The female lays 2–15 eggs. *T. hermanni* inhabits dry, scrubby or wooded areas in Mediterranean regions of Europe. Many populations have been decimated as a result of supplying tortoises to the pet trade.

tetanus Disease of humans and other animals that follows infection, usually via a wound, by the bacterium *Clostridium tetani*. This organism is resident in the gut of animals, so that contamination of a wound with manure or manured soil gives greatest risk of infection. *C. tetani* produces a powerful neurotoxin which causes uncontrollable muscle contraction; the first muscles to be affected are those of the neck and jaw (hence the alternative name 'lockjaw'). In untreated cases death from exhaustion may occur.

Tethys Sea The sea that more or less separated the two great Mesozoic supercontinents of Laurasia, in the north, and Gondwana, in the south. That land bridges between the two supercontinents existed for much of the Mesozoic is attested to by the cosmopolitan character of dinosaur faunas.

tetra *See* Characidae.

Tetracorallia Alternative name for the order Rugosa.

tetracorals *See* Rugosa.

Tetractinomorpha (phylum Porifera, class Demospongiae) Subclass of sponges many of which have a radial body structure. Most lack organic fibres in the skeleton. Most forms are oviparous.

tetracyclines *See Streptomyces*.

tetrad 1 Four homologous chromatids in a bundle in the first meiotic prophase and metaphase. 2 The four haploid cells resulting from a single meiosis. 3 *See* crystal symmetry.

tetrad analysis The use of tetrads (four haploid cells resulting from a single meiosis) to study the behaviour of chromosomes and genes in crossing-over during meiosis. Such analyses require organisms in which the products of meiosis are held together and so can be counted as units, as is true

of the meiospores contained in the ascus sac of various fungi such as *Aspergillus*, *Neurospora*, and *Saccharomyces*.

Tetragonia (family Aizoaceae) Genus of annual and perennial herbs or low shrubs in which the leaves are simple, alternate and opposite, and often succulent. The flowers are regular, bisexual, and usually yellow or green in colour. The 5–8 sepals are fused and often attached to the ovary. There are no petals, but sometimes the numerous stamens are petal-like. The ovary is superior, inferior, or half-inferior. The fruits are varied, being juicy or a leathery capsule, and enclosed in the hardened calyx tube. The plants are usually coastal in distribution, often with a scrambling habit. There are 50–60 species, all restricted to the southern hemisphere, with three species endemic to Australia.

Tetragonuridae (squaretail; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have a very elongate, slender body, two dorsal fins, an anal fin with one spiny ray, and a square or truncate tail-fin. They are probably pelagic fish, feeding on jellyfish and other planktonic organisms. There are three species, distributed widely in tropical and subtropical seas.

Tetrahymena (suborder Tetrahymenina) Genus of ciliate protozoa which have uniformly arranged body cilia, and a small, inconspicuous cytostome. They are widely used in laboratory studies on protozoa. There are several species, found in freshwater habitats, feeding mainly on bacteria.

Tetrahymenina (order Hymenostomatida) Suborder of ciliate protozoa in which the cilia in the oral region are inconspicuous. There are three families, and many genera, found in freshwater habitats. Some are parasitic.

Tetralonia *See* Anthophoridae.

tetrameric *See* dimer.

Tetramerista (family Tetrameristaceae) Genus comprising one species of rainforest tree, occurring in Sumatra, Malaya, and Borneo. It yields a useful timber, punah.

Tetrameristaceae Small family of two genera of plants, each with one species, occurring in Guyana and W. Malesia, and related to the Ternstroemiaceae.

tetramerous Of a flower, with parts in fours.

Tetrao (capercaillies; family Tetraonidae) Genus of large game birds the males of which are black with some white patches, and a bare, red wattle above the eye. Females are a mottled brown. Males have a display which involves extraordinary vocal clicking sounds. Capercaillies inhabit forests, feed on vegetable matter, and nest on the ground. There are two species, found in Europe and Asia. *T. urogallus* (capercaillie) has been reintroduced to Britain after it became extinct. *Lyrurus* species (black grouse) are sometimes included in this genus.

Tetraodontidae (pufferfish, swellfish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Large family of mostly marine fish with a rotund, scaleless body, the small dorsal fin placed well back on the body opposite the small anal fin, and a rounded tail-fin. The mouth is small, but the teeth in each jaw are fused into a solid beak, with a median division in front. They can swallow a large quantity of water, thereby inflating the body, presumably in order to discourage a predator. Some species, e.g. *Arthron stellatus* (starry pufferfish), 60 cm, of the Indo-Pacific region, are quite large and relished as food by inhabitants of many Pacific islands, despite the fact that the entrails and gonads are highly poisonous to humans. Pufferfish are also appreciated in Japan, where specially trained cooks prepare them for human consumption. There are at least 130 species, distributed worldwide.

Tetraodontiformes (Plectognathi) Order of mainly marine bony fish with either robust or compressed bodies, a small mouth, restricted gill openings and scales which are often modified into plates or spines. Among the eight families included in the order are the Balistidae (triggerfish) and the Tetraodontidae (puffers).

tetra-odotoxin *See* tetrodotoxin.

Tetraonidae (grouse; order Galliformes) Family of medium to large game birds which are mainly black, grey, and brown in colour, some with areas of white, others moulting into an all-white plumage in winter. They have short, slightly decurved bills, and many have red wattles above the eyes. Many males have erectile head feathers and inflatable air sacs for display purposes. They have short, rounded wings, and some have elaborate tail feathers. They inhabit forest and open country; feed on buds, leaves, and other vegetable matter; and nest on the ground. There are six genera, with 16 species, found in Europe, Asia, and N. America.

Tetrao urogallus (capercaillie) *See Tetrao*.

Tetrapedia *See* Anthophoridae.

Tetraphidales (subclass Bryidae) Order of small, acrocarpous mosses; the leaves are usually crowded at the tops of the sterile stems, forming cup-shaped 'gemma cups' within which discoid gemmae are formed. The capsule is unique in having a peristome with only four teeth. They are found on peaty banks, rotten logs, etc.

Tetraphyllidea (phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms which possess a scolex which may be multisuckered. Their life cycle is little understood but most inhabit three hosts during their development.

tetraploidy *See* polyploidy.

Tetrapoda Vertebrate animals which have four limbs, including the Amphibia, Reptilia, Aves, and Mammalia.

Tetrarhynchidea *See* Trypanorhyncha.

Tetrasporales (class Chlorophyceae) Order of green algae in which the vegetative cells are non-motile. Cells typically occur in colonies, e.g. *Tetraspora gelatinosa* forms amorphous green masses which may be visible to the naked eye. They are found in still freshwater habitats.

Tetratheca (family Tremandraceae) Genus of small shrubs with xeromorphic features, which are usually either glabrous or with fine, glandular hairs. The leaves are reduced in size, alternate or occasionally opposite, or whorled, usually entire, flat, and sometimes toothed, with no stipules. The flowers are regular, bisexual, solitary, and axillary, and are brightly coloured red or purple. There are 3–5 free sepals and the same number of free petals, with twice as many stamens. The ovary is superior, the style slender with a small stigma. The fruit is a flattened capsule which splits to release the small, often hairy seeds which contain the straight embryo with copious endosperm. Two species are cultivated as ornamentals. There are 39 species, all endemic to Australia, and often found as an understorey in *Eucalyptus* forests.

Tetrigidae (groundhoppers, grouse locusts, pygmy locusts; class Insecta, order Orthoptera, suborder Caelifera) Family of small, dull-coloured grasshoppers whose major characteristic is an elongated pronotum, which may cover the wings (if wings are present), and extend beyond the tip of the abdomen. Tetrigids are usually found on the ground in moist areas, and feed on algae or organically rich mud. Many species swim readily. There are about 1000 species, most of which are tropical, although 50 species are Palaearctic.

tetro-allelic Applied to a polyploid in which four different alleles exist at a given gene locus.

tetrodotoxin (tetra-odotoxin) Powerful poison which can cause general paralysis in humans after ingestion. It is found in the body, particularly the intestines, liver and gonads, of Tetraodontidae (pufferfish) and their relatives. Only after careful filleting can these fish be eaten.

Tettigoniidae (bush katydids, cone-headed grasshoppers, katydids, listroceline grasshoppers, long-horned grasshoppers, meadow grasshoppers, pine-tree katydids, shield-backed grasshoppers; class Insecta, order Orthoptera, suborder Ensifera) Family of ensiferans in which auditory communication is well developed. The ovipositor is sword-shaped. Most species are phytophagous, but some are predatory on other insects. It is the largest family in the suborder, with about 5000 species.

Teuthoidea (squids; class Cephalopoda, subclass Coleoidea) Order of cephalopods which have an internal, elongate pro-ostracum. The phragmacone may be present, the rostrum is not. Eight arms and two tentacles are present. The order probably originated in the Lower Cretaceous from a belemnoid ancestor. The squids are most closely related to the cuttlefish, both groups having ten suckered arms around the mouth.

texture 1 In petrology, the sizes and shapes of particles in rock and their mutual interrelationships. A granular texture is produced by equigranular igneous rocks with particle size from 0.05 to 10 mm. 2 In pedology, the proportions of sand, silt, and clay in the fine earth of a soil sample, which give a distinctive feel to the soil when handled, and which are defined by classes of soil texture.

Thalassocyathida (class Anthocyathea) Order of Lower Cambrian Archaeocyatha. The animals were single-walled cups in which the internal cavity contained rods or bars and dissepiments. The order contains one family, with three genera.

thallophyte Plant that is not differentiated into root, stem, and leaves; the plant body is known as a thallus.

thallose *See* Hepaticae.

thallospore Fungal spore that develops from part of a fungal hypha.

thallus Primitive type of vegetative plant body that is not differentiated into stems, leaves, and roots, although analogous structures may be present. The term is used mainly of non-vascular plants, e.g. algae, fungi, lichens, and liverworts. *See also* thallophyte.

thalweg Line joining the lowest points of successive cross-sections, either along a river channel or, more generally, along the valley that it occupies.

Thamnidiaceae (order Mucorales) Family of fungi in which sporangiola are formed. In many genera columellate sporangia are also formed. There are seven genera, with several species, found on dung, soil, decaying vegetation, etc.

Thamnophilus (antshrikes; family Formicariidae) Genus of antbirds which superficially resemble shrikes, and have stout, hooked bills. Some males are barred black and white, others are black or dark grey with white wing spots. Females are usually rufous-brown. They inhabit forests and scrub, feed on insects and berries, and nest in low bushes. There are 18 species, found in C. and S. America.

thanatosis (death feigning) Defensive behaviour in which a prey animal (e.g. an opossum, or certain snakes) feigns death. It is usually employed only when escape is impossible. The technique is often effective against predators that kill only living prey. The simulated death posture is maintained for only a short time, after which the animal 'recovers'.

thaw Onset of melting of ice and snow as the temperature rises above the freezing point.

Theaceae Family of tropical and subtropical trees and shrubs, and some scrambling climbers, in which the leaves are alternate, often evergreen, and leathery, without stipules. The flowers are regular, often solitary, showy, and usually bisexual. There are 4–7 sepals and petals and numerous stamens which are either free, in bundles, or in a tube. The ovary is generally superior, with 3–5 fused carpels with separate locules and free styles. The fruit is a capsule, berry, or achene, with a persistent calyx. The seeds have little endosperm. The family is often split into eight or more smaller families, separated by the characteristics of the reproductive system. Many species are ornamentals, including the well-known *Camellia japonica*, but the best-known and economically most valuable member of the family is *C. sinensis*, the tea plant. This species has been cultivated for many centuries and contains caffeine, polyphenols, and essential oils. There are about 29 genera, with more than 1000 species, in

the family, most of which are restricted to tropical and subtropical regions, and centred in Asia and America.

theca 1 (phycol.) Shell-like structure surrounding the cell in certain algae. 2 *See* Graptolithina.

Thecata Alternative name for the hydroid suborder Calyptoblastina.

Thecideacea (suborder Thecideidina) Superfamily of Brachiopoda, whose members have punctate shells. They reached their acme in the Upper Cretaceous, and are now represented by two extant genera.

Thecideidina (class Articulata) Suborder of Brachiopoda of uncertain ordinal position, but possibly derived from the order Strophomenida. Members are small, cemented, without a pedicle, variable, and irregular in outline. They first appeared in the Upper Permian.

thecodont *See* acrodont.

Thecodontia 'Tooth-in-socket' reptiles, and the most primitive order of the Archosauria ('ruling reptiles'), ranging from the Upper Permian to the Upper Triassic. They were ancestral to the dinosaurs, pterosaurs, and crocodiles.

Thecodontosaurus browni One of the first of the ancestral dinosaur group the Thecodontidae (the 'tooth-in-socket' reptiles) which flourished during the Early Triassic. It grew to 2–3 m in length and had a small head and neck. Essentially it was a quadruped, but it could walk on its hind legs. It was described by Sealey in 1895.

Thecosomata (shelled pteropods; phylum Mollusca, class Gastropoda) Order of opisthobranch gastropods which have a planktonic mode of life, aided by fins or lobes on the foot. The mantle cavity is large and the shell may be coiled spirally. Individuals are small in size and are ciliary feeders.

Theileria (class Piroplasmea) Genus of protozoa which includes some important pathogens of domestic animals, including cattle and sheep. *T. parva* causes the commonly fatal disease 'east-coast fever' which affects cattle in many parts of Africa; the disease is transmitted by ticks.

Thelephora (family Thelophoraceae) Genus of fungi in which the fruit bodies are variously shaped, according to species; they may be more or less branched, are typically leathery in texture, and bear a well-developed, wrinkled or smooth hymenium. *T. terrestris* ('earth fan') forms fan-shaped fruit bodies 3–8 cm across, erect or horizontal, reddish to brown, often in clusters. They are common in conifer woods and heaths.

Thelephoraceae (order Aphyllophorales) Family of fungi in which the fruit body is composed of only one type of hypha; the flesh usually darkens or turns greenish when treated with potassium hydroxide. Typically spores are ornamented. Most species are found on the ground, but some grow on wood.

Theligonaceae *See* Cynocrambaceae.

Thelymitra (sun orchid; family Orchidaceae) Genus of terrestrial orchids which have underground tubers. The leaves are linear, usually deeply channelled, and often broad, with a single leaf to the flower. The leaf dies down at the end of flowering, a new tuber is generated, and the old one decays. The flowers open and close according to the brightness of the Sun, hence their common name, and are white, pink, blue, or yellow. They are symmetrical, and held in a terminal raceme in a very long (up to 1 m) stem. Both the sepals and petals are similar, with the lower petal unmodified. The stamen column is short and stout, with a pair of small wings. The fruit is a three-celled capsule which contains many small seeds. Many species are cultivated as pot plants. There are 45 species, found in Australasia, of which about 40 are endemic to Australia.

Thelypteridaceae Family of leptosporangiate ferns with the mixed type of sorus. The sori are superficial, small, near the pinnule margins, and have either no indusium or a kidney-shaped one that is soon evanescent. The leaves are normally bipinnate and hairy; scales on the frond stalk or stipe are few. *Thelypteris thelypteroides* (marsh fern) is the most familiar European and temperate N. American species; it has creeping rhizomes and grows in fen peat. The family is now regarded as containing some 28 genera, mostly tropical.

Thelypteris thelypteroides (marsh fern) *See* Thelypteridaceae.

thelytoky Obligatory parthenogenesis, such that populations consist entirely of females, with occasional functionless males. It is the only genetic system in which fertilization (the union of egg and sperm) is eliminated completely. Evolution in thelytokous species can therefore take place only by favourable mutations occurring in a single individual, and persisting in the line descending from that individual.

Themeda (kangaroo grasses; family Gramineae, subfamily Panicoideae, tribe Andropogoneae) Genus of coarse, tussock-forming, perennial grasses whose spikelets are borne on racemes in pairs, usually one stalked and sterile, the other sessile and fertile. The racemes are single or paired, or held in a panicle with many branches. There are usually subtending leaves with the inflorescence. There are 10 species, found in S. and E. Africa, Asia, and Australia. The genus includes *T. triandra*, the dominant grass of the savannah areas of tropical Africa. In Australia, *T. australis* is common in northern central regions on richer soils of valley flows and alluvial beds.

Theobroma (family Sterculiaceae) Genus of understorey trees, all of restricted natural range, in which the flowers are cauliflorous and ramiflorous, and pentamerous. The fruit is a large drupe, the seeds numerous, and surrounded by pulp derived from the integuments. Cocoa comes from *T. cacao*. There are 22 species, occurring in the rain forests of S. America.

theory of differentiation *See* differentiation, theory of.

theory of generic cycles *See* generic cycles, theory of.

Theraphosidae (tarantulas; order Araneae, suborder Mygalomorphae) Family of very large, hairy, non-social spiders, which possess claw tufts, four spinnerets, and eight, closely grouped eyes. They are known as 'tarantulas' in the USA. They feed on large insects and occasionally reptiles, amphibians, or nestling birds. Most species chew their prey, sometimes dipping it in water. Few, if any, of the American species are dangerously poisonous to humans. Defensive displays include the raising of chelicerae, pedipalps, and first walking legs, and some species stridulate as well. Large species become mature in 3–10 years, the male living only for months but the female for up to 20 years (in captivity) after maturing. N. American species live in deep burrows and some Amazonian species are arboreal. They are basically tropical in distribution.

Theraponidae (grunter, tigerfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine and freshwater fish with elongate to oblong, compressed bodies, spiny and soft-rayed parts of the dorsal fin that are separated by a distinct notch, a slightly forked tail-fin, and the pelvic fins inserted behind the bases of the pectoral fins. *Therapon jarbua* (crescent perch or tigerfish), 28 cm, is one of the marine species of the family. Possibly 14 species are found in the freshwater systems of Australia, including, for example, *Hephaestus fuliginosus* (sooty grunter), 38 cm. There are about 17 species in the Indo-Pacific region.

Therapon jarbua (crescent perch, tigerfish) *See* Theraponidae.

Therapsida Order of synapsid reptiles, ancestral to the mammals, ranging from the latter part of the Permian to early Jurassic times.

Therevidae (stiletto flies; class Insecta, order Diptera, suborder Brachycera) Small family of flies in which most adults are elongate, with dense body hair, and slender legs. Their common name refers to the long, thin abdomen and broad thorax, known as the 'blade' and 'handle' respectively. The third antennal segment has an apical style. In the wing venation R_1 is usually long, and cell M_3 is present. The empodium is absent, or represented by a weak bristle. Adults are thought to be predacious, but observations to support this appear sparse. Larvae are predacious on other insects in leaf mould, soil, and decaying matter. About 500 species have been described. *See also* venation.

Theria (phylum Chordata, superclass Gnathostomata, class Mammalia) Subclass comprising the three infraclasses Pantotheria (of extinct ancestral forms), Metatheria (the marsupials), and Eutheria (the placental mammals), distinguished from the Prototheria principally by their teeth and by the structure of the sides of the skull, formed in therians by large squamosal and alisphenoid bones.

Theridiidae (cobweb spiders, comb-footed spiders; order Araneae, suborder Araneomorphae) Family of spiders, which have a vertical comb of serrated bristles on the tarsi of the fourth legs which is used to throw threads of silk over the prey items caught in their webs. In general they are medium to small (0.1–1.5 cm long), glossy species, with large, protuberant eyes, and the habit of making tangled, three-dimensional webs with sticky threads on the periphery. There are more than 1300 species, including the infamous *Latrodectus mactans* (black widow spider) whose venom is toxic to mammals.

thermal Used as a noun, the term refers to air that rises in a column over some localized heat source; it rises through the atmospheric environment as a result of its reduced density. Intense heating over land (and particularly over some types of surface) results in adiabatic expansion and uplift. When thermals rise to condensation level short-lived clouds (e.g. fair-weather cumulus) may form. Continued strong thermals can result in growth of the cloud to large cumulus or cumulonimbus. When the upward growth reaches a stable layer, the cloud top may spread laterally.

thermal equator The zone of highest mean temperature over the Earth, either in the annual or long-range average or at a given moment. On the long-term average, it is located around 5 °N latitude. This position north of the geographical equator results from the generally rather higher temperature of the northern hemisphere as compared with the southern hemisphere, with the glaciated antarctic continent maintaining colder summers there than in the arctic. *See also* cold pole.

thermal low Basically non-frontal depression associated with strong daytime heating of land surfaces, mainly in summer, occurring for example in Arizona, Spain, and in N. Indian low-pressure cells. The occurrence of thermal lows is also influenced by imbalances in the main windstreams in the upper troposphere.

thermal wind The vertical geostrophic wind shear for a given layer of the atmosphere, the vector that defines the difference between the geostrophic wind at the bottom and at the top of the layer. It is parallel to the mean isotherms (thickness contours) and blows with cold air (low thickness) on the left in the northern hemisphere and on the right in the southern hemisphere.

thermic *See* pergelic.

Thermobia domestica *See Lepismodes inquilinus*.

thermoclastis Process of physical weathering whereby the stresses set up when a rock is alternately heated and cooled become sufficient to cause failure. It may bring about surface spalling (splintering) because of the low conductivity of rock, and may be particularly effective on polymineralic rocks because of varying coefficients of expansion. Some observational and experimental evidence suggests that the process may be less effective than was believed formerly. *See also* exfoliation.

thermocline Generally, a gradient of temperature change, but applied more particularly to the zone of rapid temperature change between the warm

surface waters (epilimnion) and cooler deep waters (hypolimnion) in a thermally stratified lake in summer.

thermoduric Applied to an organism (usually a micro-organism) that can tolerate relatively high temperatures; often used specifically for micro-organisms that survive the process of pasteurization.

thermograph Instrument that gives a continuous record of temperature for a day or for a week. The device uses a helical strip of two metals with differing coefficients of expansion. The resulting opening and closing of the coil operates a pen which produces a line over a calibrated chart on a round clock drum.

thermohygrograph *See* hygrothermograph.

thermokarst Periglacial land-form assemblage characterized by enclosed depressions (some with standing water) and so presenting a karst appearance. It is caused by the selective thaw of ground ice associated with thermal erosion by stream and lake water.

thermophile Organism which grows best at relatively high temperatures, e.g. 45 °C or above.

thermophilous species Warmth-loving species. In pollen analysis the term refers in particular to a species, genus, or family characteristic of warmer environments than those otherwise indicated by the pollen record.

thermopile Instrument for the measurement of direct and diffuse short-wave radiation, which utilizes a bank of thermocouples covered by a glass or other transparent dome.

thermosphere The upper zone of the atmosphere, above about 80 km where solar radiation of the shortest wavelengths is absorbed. In this zone, which includes the ionosphere, temperature increases with height, but the very low density produces minute heat capacity. *See also* atmospheric structure.

therophyte One of Raunkiaer's life-form categories, being a plant that completes its life cycle rapidly during periods when conditions are favourable and survives unfavourable conditions (e.g. cold, heat, or competition) as seed; it is thus an annual or ephemeral plant. Therophytes are very typical of desert environments and cultivated land. *Compare* chamaeophyte; cryptophyte; hemicryptophyte; and phanerophyte.

Theropoda Suborder of saurischian dinosaurs which consists exclusively of bipedal, carnivorous forms. It includes the coelurosaurs and the carnosaurs, and ranged from the Upper Triassic to the Cretaceous.

thiamine Vitamin B_1. It contributes to the formation of the important coenzyme thiamine pyrophosphate which is involved in the oxidative decarboxylation of alpha-keto acids and transketolase reactions. A deficiency of this compound in humans causes beri-beri.

thick-headed flies *See* Conopidae.

thick-knees *See* Burhinidae.

thick-legged beetle *See* Oedemeridae.

thicklip gourami (*Colisa labiosa*) *See* Belontiidae.

thickness The difference in height in the atmosphere between particular pressure levels, e.g. between 1000 and 500 millibars. Isolines of a given interval on charts are termed 'thickness lines'.

thigmotaxis (stereotaxis) Change in direction of locomotion in a motile organism or cell made in response to a tactile stimulus (touch), where the direction of movement is determined by the direction from which the stimulus is received. It may inhibit movement, causing the organism to come into close contact with a surface. Thigmotaxis is commonly observed in insects.

Thigmotrichida (subclass Holotrichia) Order of ciliate protozoa which have thigmotactic cilia at the anterior end of the body by means of which the organisms maintain contact with their hosts. They are parasites or commensals in molluscs in freshwater and marine habitats. There are two suborders.

thigmotropism (haptotropism) The tropic response of a plant organ to the stimulus of touch.

thin To remove some of the trees in an area to enable those that remain to grow larger, especially in girth.

Thinocoridae (seedsnipe; order Charadriiformes) Family of plump, medium-sized, brown, speckled birds, which have short, conical bills, and nostrils protected by a flap. They have long, pointed wings, a short tail, and short legs. When disturbed they have a zigzag flight, like snipe. They inhabit open country, feed on seeds, and nest on the ground. There are two genera, with four species, found in S. America.

Thiobacillus Genus of bacteria not assigned to any taxonomic family. The cells are Gram-negative, small, rod-shaped, and often motile with a single flagellum at one end. Energy is obtained by the oxidation of sulphur or sulphur-containing compounds, e.g. sulphide and thiosulphate. Most species require the presence of air for growth. There are several species, found in soil, marine and freshwater environments, acidic mine waters, sulphur springs, etc.

thiol *See* sulphydryl.

Thismea *See* Burmanniaceae.

Thomisidae (crab spiders; order Araneae, suborder Araneomorphae) Family of spiders whose common name refers to their sideways-running gait when disturbed. They have legs with only two claws, the anterior legs being held laterally, not forward. They are broad-bodied, and generally the first two pairs of legs are more robust than the posterior two pairs. The spinnerets are small and inconspicuous. Some species live on bark, and all have a potent arthropod venom. *Misumena vatia* can change its colour to match the yellow or white flowers on which it sits in wait for prey items.

thongweed *See* sea-thong.

Thoracica (typical barnacles; phylum Arthropoda, subphylum Crustacea, class Cirripedia) The familiar barnacles, with a mantle usually covered with calcareous plates, and with six pairs of well-developed, thoracic feeding appendages (cirri). The group includes the suborder Lepadomorpha (stalked or pedunculate barnacles), comprising the genera *Lepas*, *Scalpellum*, *Pollicipes*, *Conchoderma*, and *Heteralepas*; the suborder Verrucomorpha (asymmetrical sessile barnacles), comprising the single genus *Verruca*; and the suborder Balanomorpha (symmetrical sessile barnacles), comprising the genera *Balanus*, *Chthamalus*, *Catophragmus*, *Octomeris*, *Tetraclita*, *Pyrgoma*, *Coronula*, and *Xenobalanus*.

thoracic vertebrae *See* lumbar vertebrae.

Thoracostei Alternative name for bony fish (including the sticklebacks) now included in the order Gasterosteiformes.

thorax The three segments of the body of an insect that lie between the head and the abdomen. Each thoracic segment carries a pair of legs. The three thoracic segments are termed the prothorax, mesothorax, and metathorax. The mesothorax and metathorax may each carry a pair of wings.

thorium *See* radiometric dating.

thorn-apple (*Datura stramonium*) *See Datura*.

thornback ray *See* Rajidae.

thornbills *See Acanthiza*; and Acanthizidae.

thorn bug *See* Membracidae.

thorn forest (thorn scrub, thorn woodland) Tropical vegetation with thorny shrubs and bushy trees, perhaps with a few taller trees, set in a sparse ground flora in which grasses are often lacking. It is in this last respect that thorn forest differs principally from savannah woodland, the paucity of grasses reflecting the increased aridity of the climate. Thorn forest merges in even drier regions into semi-desert scrub.

thorn scrub *See* thorn forest.

Thornthwaite climate classification System for describing climates, devised in 1931 by C. W. Thornthwaite, that divides climates into groups according to the vegetation characteristic of them, the vegetation being determined by precipitation effectiveness (P/E, where P is the total monthly precipitation, and E is the total monthly evaporation). The sum of the monthly P/E values gives the P/E index, which is used to define five humidity provinces, with associated vegetation. A P/E index of more than 127 (wet) indicates rain forest; 64–127 (humid) indicates forest; 32–63 (subhumid) indicates grassland; 16–31 (semi-arid) indicates steppe; less than 16 (arid) indicates desert. In 1948 the system was modified to incorporate a moisture index, which relates the water demand by plants to the available precipitation, by means of an index of potential evapotranspiration (PE), calculated from measurements of air temperature and day length. In arid regions the moisture index is negative because precipitation is less than the PE. The system also uses an index of thermal efficiency, with accumulated monthly temperatures ranging from 0, giving a frost climate, to more than 127, giving a tropical climate. *See also* Köppen climate classification; and Strahler climate classification.

thorn woodland *See* thorn forest.

thorny catfish *See* Doradidae.

thorny devil *See Moloch horridus*.

thrashers *See* Mimidae; and *Toxostoma*.

Thraupidae (tanagers; order Passeriformes) Family of fairly small, brightly coloured birds, which have short to medium, rather conical bills; short to long wings; short to medium-length tails; and short legs. They inhabit forests and bushes, feed on fruit and insects, and nest in trees and bushes. There are 57 genera, with about 250 species, many kept as cagebirds, found in N., C., and S. America.

threadfin 1 *See* Polynemidae. 2 (threadfin bream) *See* Nemipteridae. 3 (threadfin sculpin, *Icelinus filamentosus*) *See* Icelidae.

thread snakes *See* Leptotyphlopidae.

threadworms *See* Nematoda.

threat Kind of communication by which an animal may keep rivals or potentially dangerous animals of other species at bay without fighting.

three-cell model An attempt to represent the atmospheric circulation systems over a hemisphere by three adjoining vertical cells of meridional surface motion, transferring energy from equatorial to polar regions. This concept of heat transfer by meridional circulation has generally been superseded by more modern ideas of travelling waves. *See also* Hadley cell; and Rossby waves.

three-spined stickleback (*Gasterosteus aculeatus*) *See* Gasterosteidae.

three-toed jacamar (*Jacamaralcyon tridactyla*) *See* Galbulidae.

threonine An aliphatic, polar, alpha-amino acid.

Threskiornis (ibises; family Threskiornithidae) Genus of large, white ibises, which have a black, decurved bill, and bare, black skin on the head and neck. They inhabit wetland areas; feed on crustaceans, fish, and other animals; and nest colonially in trees or on the ground. There are three similar species, found in Africa, Asia, Indonesia, and Australia.

Threskiornithidae (ibises, spoonbills; order Ciconiiformes) Family of medium to large birds which have white, grey-brown, or greenish-black plumage. Their bills are either long, slender, and decurved, or long and flattened, with a spatulate tip. Their necks and wings are long and tails short. Their legs are long with long, basally-webbed toes. They are gregarious; inhabit shores and marshes; feed on fish, crustaceans, reptiles, and insects; and nest in trees or on the ground. There are about 19 genera, with 32 species, found nearly worldwide.

thrips *See* Thysanoptera.

thrombin Proteolytic enzyme involved in the clotting of blood, generated from its inactive zymogen prothrombin in the presence of calcium

ions, thromboplastin, and other factors. It acts upon the soluble fibrinogen in blood to produce insoluble fibrin by catalysing the removal of the fibrinopeptides A and B from fibrinogen. *See also* blood clotting; and blood plasma.

thromboplastin One of a group of lipoprotein compounds apparently released by blood platelets at the site of an injury. In the presence of calcium ions and other factors, it catalyses the conversion of prothrombin into thrombin during the clotting of blood.

throughflow (interflow) The passage of rainfall through the regolith at a shallow depth and roughly parallel to the slope surface. It tends to be concentrated at the surface of a less permeable layer, and so commonly occurs at the junction between A and B soil horizons.

thrush Condition of the mucous membranes of the mouth or vulva caused by infection with the fungus *Candida albicans*; whitish spots appear and may spread rapidly to cover the entire mucous membrane.

thrushes 1 *See* Turdidae; *Turdus*; and *Zoothera*. 2 (laughing thrushes) *See Garrulax*. 3 (nightingales) *See Luscinia*. 4 (rock thrushes) *See Monticola*.

thrust Tectonic structure that is a low angle or reverse fault.

Thryonomyidae (cane rats, cutting grass, grass-cutters; order Rodentia, suborder Hystricomorpha) Family of heavily built, burrowing rodents which have small eyes and ears, and short, fully haired tails. The fifth digit is vestigial on all limbs. The hair is coarse and flattened, has grooves on its upper surfaces, and grows in clumps of five or six hairs. Cane rats are distributed widely throughout Africa south of the Sahara; in W. Africa they are currently undergoing domestication as they are widely relished for food. There are two species in a single genus, *Thryonomys*.

Thryptomene (family Myrtaceae) Genus of shrubs which have small, opposite, crowded leaves. The flowers are solitary, numerous, and mostly in the upper leaf axils; they are white, yellow, or pink. The five or 10 stamens are held opposite the calyx lobes. There are five round, spreading petals. The fruit is a small nut with numerous seeds. Several species are cultivated as ornamentals. There are about 35 species, all endemic to Australia, and mainly confined to the west.

thufur Earth hummock some 0.5 m high and 1–2 m wide, which is found in contemporary and past periglacial environments. Normally it possesses a core of sediment, which suggests that a form of differential heaving by ground ice is responsible for its development.

Thuidiales (subclass Bryidae) Order of pleurocarpous mosses which range in size from minute to large. The primary stems are creeping, with secondary stems prostrate to ascending, irregularly branched to regularly one- to three-pinnate. The leaves are typically ovoid, nerveless or with a short double nerve or a single nerve ending below the leaf tip. There are several genera, found in a wide range of habitats. *Thuidium tamariscinum* is a very attractive moss: bright green in colour, and intricately, tripinnately branched to give a fern-like appearance. It is a common and conspicuous moss in woods and on shady banks.

Thuja (family Cupressaceae) Genus of evergreen, coniferous trees in which the leaves are small, and closely adpressed to the flattened twigs. The cones have three or four pairs of scales, only the middle ones being fertile and bearing paired seeds. *T. plicata* is western red cedar, and all members of the genus are known as 'arbor vitae'. There are six species, occurring in E. Asia and N. America.

thumbless bat *See* Furipteridae.

thundercloud Popular term for cumulonimbus, which is associated with thunderstorms.

thunderstorm Storm of fairly local scale in which strongly developed cumulonimbus cloud produces thunder and lightning, usually with rain, and strong, gusting wind, often with hail.

Thunnus alalunga (albacore) *See* Scombridae.

Thunnus thynnus (Atlantic tuna) *See* Scombridae.

Thylacinidae (order Marsupialia, superfamily Dasyuroidea) Family comprising the one species *Thylacinus cynocephalus* (marsupial (Tasmanian) 'wolf' or 'tiger'), a highly specialized carnivore bearing many similarities to the Borhyaenidae of S. America, due almost certainly to convergence. Probably the species shares a common ancestry with the Dasyuridae and many authorities place it in this family, but such classification remains insecure in the absence of more information concerning ancestral forms. Thylacines were present in New Guinea and Australia during the Pleistocene, but in modern times became restricted to Tasmania and today they are believed to be extinct, the last known specimen having died at Beaumaris Zoo, Hobart, on 7 September 1936. Subsequent reports of sightings have not been confirmed.

Thylacinus cynocephalus (Tasmanian 'wolf') *See* Thylacinidae.

Thylacomyidae *See* Perameloidea.

thylakoid One of the membranaceous discs or sacs that form the principal sub-units of a granum in chloroplasts.

Thymelaeaceae Family of shrubs, with a few trees and climbers in which the bark is fibrous. The wood often has included phloem. The leaves are simple, and sometimes opposite. The flowers are hermaphrodite, and regular. The calyx is tubular, commonly coloured, and lobed; petals are often absent, or episepalous; the stamens are episepalous; the ovary is superior. The seeds have a caruncle or aril. There are 50 genera, with 500 species, occurring in the tropics, especially of Africa, and in temperate regions.

thymine Pyrimidine base that occurs in DNA.

thymol *See* Labiatae.

thyroglobulin Iodinated protein of the gelatinous colloid of the thyroid gland which is chiefly responsible for the storage of iodine in that gland and from which the hormones thyroxine and triiodothyronine are formed.

Thyropteridae (disc-winged bats, sucker-footed bats; order Chiroptera, suborder Microchiroptera) Family of bats in which there are adhesive sucker discs, borne on stalks on wrists and ankles, used when the animals roost in smooth banana leaves that have not yet opened and therefore are rolled. The first digit of each limb bears a claw. The nose is simple, with no leaf; the ears are simple and immobile; the tail extends a little beyond the edge of the uropatagium. Thyropteridae occur in tropical C. and S. America and in the W. Indies. There are two species in a single genus, *Thyroptera*.

thyrotropic hormone Glycoprotein hormone secreted by the adenohypophysis that stimulates the thyroid gland to produce thyroid hormones and release thyroxine.

thyroxine Iodinated amino acid, formed in the thyroid gland from the proteolysis of thyroglobulin. It is the major hormone of this gland and exerts a positive control of the basal metabolic rate (BMR) of virtually all tissues and organs in the body.

Thyrsoidea macrura (longtailed reef-eel) *See* Muraenidae.

Thyrsopteridaceae Family of tree ferns of ancient origin, included by some authors with other tree ferns in the Cyatheaceae. They have marginal gradate sori, which in *Thyrsopteris* are produced on specialized fertile pinnae, and have cup-like indusia. In *Cibotum*, the sori are on the margins of ordinary pinnae and have a two-lipped indusium. There are three genera. *Thyrsopteris*, with only one species, *T. elegans*, is endemic to Juan Fernandez and seems to be a very ancient relic. *Cibotum* has a number of species and is widespread in tropical forests.

Thyrsopteris elegans *See* Thyrsopteridaceae.

Thysanoptera (thrips; class Insecta, subclass Pterygota) Order of slender, minute (mostly 0.5–2 mm long), pale to blackish insects which have short, 6–9-segmented antennae, short legs, and asymmetrical, sucking mouthparts which form a conical beak on the ventral surface of the basal head area. Wings, when present, are in two pairs, with very reduced venation and long fringe hairs. The two suborders, Terebrantia and Tubulifera, differ in the shape of the abdomen and development of the ovipositor. Most thysanopterans are herbivores and many are pests of cereals and fruit trees (e.g. onion thrips, grain thrips, pea thrips, and greenhouse thrips). A few act as vectors of plant diseases. Some thrips are predacious on other small arthropods, and many feed on fungal spores. There are about 4500 species, distributed worldwide.

Thysanothus (family Liliaceae) Genus of small herbs which have erect and twining stems. Each plant has few tough leaves which are radical and linear. The roots are fibrous, with tubers. The blue, star-like flowers are held in panicles or umbels on thin, wiry stems. There are three narrow sepals, and three broad petals edged with a fringe. Of the six yellow stamens, three are usually longer than the others. The fruit is a globular or oval capsule with three cells, which splits to release several black seeds. There are about 30 species, almost all restricted to W. Australia, but one is present in SE Asia.

Thysanura (bristle tails, silverfish; class Insecta, subclass Apterygota) One of the two orders of the Apterygota, whose name is derived from the Greek *thysanos*, 'fringe', and *oura*, 'tail', comprising ectognathous insects which are more or less flattened and adapted for running. The tapering body, usually less than 10 mm long, may be bare or covered with silvery scales; it is sometimes pigmented; and ends in three segmented, bristle-like appendages. Ocelli are absent in most species, and the compound eyes are reduced or absent, and never contiguous as in the Archaeognatha. The mandibles are dicondylar (with a double articulation), and the maxillary palps are five-segmented. The thorax is not arched, and the coxae lack styles, although they are present on most abdominal segments. Most species are free-living and very agile, with sexual and parthenogenetic reproduction. Post-embryonic development may be slow, or take as little as 2–3 months, and the reproductive potential is great. Thysanurans live in damp habitats, e.g. leaf litter and rocky shores. One family, the Nicolettidae, are cavernicolous (cave-dwelling) and herbivorous. Several species are found in human habitations, where they feed on scraps, carbohydrate and dextrin compounds, and glue and sizes. Distributed throughout the world, and more diverse than the Archaeognatha, some are of economic importance. *Lepismodes inquilinus* (firebrat) inhabits warm buildings, where *Lepisma saccharina* (silverfish) also occurs, often inhabiting damp books. There are five families, with 330 species. *See also* Lepismatoidea; and Machiloidea.

tibia 1 In a tetrapod vertebrate, the anterior long bone of the lower hind limb (the 'shin' bone). 2 In an insect, the long and often narrow segment of the leg that articulates proximally with the femur and distally with the tarsus. The tibia contains the muscles that control the tarsi. The musculature operating the tibia is found in the femur, and acts through the agency of a tendon.

tibiale The pre-axial proximal tarsal bone of the ankle.

tibiotarsal joint The avian equivalent of the ankle: the joint between the tibiotarsus, the bone formed by the fusion of the tibia with the upper tarsals, and the metatarsus.

tibiotarsus *See* tibiotarsal joint.

Tichadromadidae (wallcreeper; order Passeriformes) Monotypic family comprising *Tichodroma muraria*, which is a small, grey bird with brilliant crimson and black wings. It has a long, slender, decurved bill; long, broad wings; and a short tail. Its legs are short, and its feet large. It inhabits high mountains, moving lower in winter; feeds on

insects; and nests in rock crevices. It is found in S. Europe and Asia.

tidal current Alternating, horizontal movement of water associated with the rise and fall of the tide these being caused by astronomical forces. Offshore tidal currents tend to exhibit rotary patterns, while in areas near coasts the currents follow rectilinear paths and reverse periodically (ebb and flow currents). Tidal currents can often reach velocities of 2.5 m/s near shores.

tidal flat Intertidal sandflat, mud-flat, and marsh area developed in some lagoons in mesotidal areas, and in protected bays and estuarine areas along macrotidal coasts. Extensive tidal flats occur in the Wash (E. England), Wadden See (Holland), and along the North Sea German coast. Tidal flats also occur in warmer climates, as in the Persian Gulf, where carbonate and evaporite deposits develop. In tropical areas tidal flats tend to be colonized by mangrove swamps.

tidal inlet Narrow channel that connects the open sea with a lagoon. Tidal inlets often occur in barrier island systems and are typified by small-scale deltas at each end of the inlets, resulting from the high-velocity, tidal-reversal currents that flow through the channels.

tidal range The difference in height between consecutive high and low waters. The tidal range varies from a maximum during spring tides to a minimum during neap tides. In tide tables daily high- and low-water heights are given for each geographical locality mentioned.

tidal stream The flow of water in and out of estuaries, bays, and other restricted coastal openings associated with the rise and fall of the tide. Landward (flood) and seaward (ebb) streams or currents often follow different paths in shallow-water areas, so forming ebb/flood avoidance cells and a braided pattern of sandbanks in these coastal openings.

tide Periodic rise and fall of the Earth's oceans, caused by the relative gravitational attraction of the Sun, the Moon, and the Earth. Variation in tides is caused by: (a) changes in the relative positions of Sun, Moon, and Earth; (b) uneven distribution of water on the Earth's surface; (c) variation in the sea-bed topography. Diurnal tides are those with one high and one low water during a tidal day (24 hours and 50 minutes), while semi-diurnal tides are those with two high and two low waters during the same period.

Tieghemopanox (family Araliaceae) Genus of trees and shrubs with alternate, pinnate leaves which are almost or completely sessile, and often toothed. The flowers are regular, small, and unisexual, held in umbels. The calyx is very small, often without distinct teeth. There are five petals, occasionally only four, and the same number of stamens. The ovary is of five fused carpels. The fruit is a drupe with five seeds. There are 35 species, found only in Australia and the New Hebrides.

tiger (*Panthera tigris*) *See Panthera*.

tiger barb (*Barbus tetrazona*) *See* Cyprinidae.

tiger beetle (*Cicindela*) *See* Carabidae.

tiger butterflies *See* Danainae.

tigerfish *See* Theraponidae.

tiger flathead (*Platycephalus richardsoni*) *See* Platycephalidae.

tiger moths *See* Arctiidae.

tiger shark (*Galeocerda cuvieri*) *See* Carcharhinidae.

tight junction Region of the cell surface, of variable size, and situated just below the apical border where the membranes of adjacent cells are fused to form a pentalaminar structure. In simple epithelial layers tight junctions often form a continuous layer (the zonula occludens). Their function appears to be the provision of areas of contact between cells of enhanced permeability and low electrical resistance. They occur in tissues such as the blood–brain barrier and cardiac muscle, where such features are advantageous.

Tilapia *See* Cichlidae.

tile drain Short lengths of concrete or ceramic pipes placed end to end to make a drain, which is laid at any appropriate depth and spacing to remove water from the soil, water entering at the joints.

tilefish *See* Malacanthidae.

Tilia (lime, linden; family Tiliaceae) Genus of trees with large, blunt buds, and alternate, usually heart-shaped, leaves on long stalks. The flowers are in small stalked cymes with a large oblong bracteole fused to the inflorescence stalk for some distance. Flowers are yellow or white, fragrant, and insect-pollinated (unlike most northern-temperate forest trees); and have five free sepals and petals, many stamens, and a five-celled ovary which forms a globular or ovoid one-celled, 1–3-seeded nut. The nectar is eagerly sought by bees, who produce an excellent honey where it is plentiful. The timber was formerly much used for wood-carving; Grinling Gibbons (1648–1721) used it greatly. The young leafy shoots were used formerly to feed stalled cattle where herbage was scarce, and a kind of bread was made from the starch-rich phloem tissues. There are some 30 species in the northern temperate zone. *Tilia* species, especially *T. cordata*, were dominant in pre-Neolithic times in many English and European forests, but have become much scarcer, due to human activities, though remaining locally important in less modified forests in Eurasia and N. America. The hybrid *T. cordata* × *T. platyphyllos* is much planted in parks and avenues in Europe.

Tiliaceae Dicotyledonous family of trees, shrubs, and a few herbs. The leaves are usually alternate, and the inflorescences cymose. Flowers are regular, bisexual, with superior ovaries; the (usually) five sepals are valvate in bud and there are normally five petals and many free stamens. The fruit is a capsule, a drupe, or a nut. A number of *Tilia* species are used for timber; *Corchorus capsularis* is the source of jute; and other species are grown for ornament. There are about 41 genera, with 400 species, occurring mainly in the tropics, but with some temperate species.

Tilia cordata *See Tilia.*

Tiliqua rugosa (stump-tailed skink; order Squamata, suborder Sauria (Lacertilia), family Scincidae) Large (about 36 cm long) skink in which the tail resembles the head in shape, being short, broad, and rounded at the end. The cobalt-blue tongue is used in a threat display. The skink burrows in sand. It is herbivorous, and occurs in SW Australia.

till Collective term for the group of sediments laid down by the direct action of glacial ice without the intervention of water. The sediments may be classified in terms of particle size (they range between clay-rich and clast-dominated types, according to source area and travel distance), or grouped by the basic process of debris release: subglacial melt gives rise to 'lodgement till', surface ablation leads to 'flow till' or 'ablation till', and the general thaw of static ice produces 'melt-out till'.

tiller In grasses, a lateral shoot arising at ground level.

Tilletia (family Tilletiaceae) Genus of smut fungi which form unicellular teliospores and which typically attack the ovaries of a host plant (a member of the Gramineae). There are many species. *T. caries* is responsible for bunt disease of wheat.

Tilletiaceae (order Ustilaginales) Family of smut fungi in which the germination of a resting spore gives rise to a non-septate promycelium which in turn bears clusters of basidiospores at its apex. All are parasitic on plants, some causing important diseases of cereals.

tillite Lithified deposit of boulder clay or till produced by the action of glaciers.

Tillodontia Order of mammals from the Palaeocene and Eocene of the northern continents, which culminated in a bear-size animal with rodent-like incisors.

tilloid General term applied to a chaotic mixture of large blocks set in a clay-rich matrix; such mixtures include mudflows, landslide deposits, and tillites.

till plain Smooth plain underlain by till. It may be well preserved, as in mid-western USA, or may be dissected by later erosion, as in the lowlands of C. and E. England.

tilth The physical condition of the soil that determines its suitability for plant cultivation.

Timaliidae (babblers; order Passeriformes) Family of fairly small birds, most of which are brown, grey, and buff, but some of which have brighter colours. They have varied bill shapes, short rounded wings, and many have long tails. Their feathers are soft, and long on the back. They are mainly arboreal, although some are terrestrial, and inhabit forests and scrub. They feed on insects and fruit, and nest in cup-shaped or domed nests in trees, bushes, grass, or on the ground. There are about 57 genera, with 275 species, found in Europe, Africa, Asia, and Australasia.

timber 1 Wood in the form of unsquared logs. 2 Tree trunks that are suitable for beams or for sawing into planks.

timber beetle *See* Cerambycidae.

timber-line (waldgrenze) Line that marks the altitudinal limit of trees that are in close canopy and that grow erect and tall. It occurs below the baumgrenze or tree-line proper, and below the kampfzone (in which the trees often show the krummholz condition).

timber rattlesnake *See Crotalus horridus.*

timber tree A sound tree that is suitable for construction work.

time-scale (geol.) Subdivision of geological time based on one of several different criteria. Time-scales related to the rate of sedimentation, the rate of sea-floor spreading, or radiometric data are known to geologists.

time series Data set in which the intervals are of equal time and arranged in order of occurrence. The series may be for individual or averaged values which can be analysed by statistical techniques including spectrum or harmonic analyses.

timothy-grass bacillus (*Mycobacterium phlei*) *See Mycobacterium.*

Tinamidae (tinamous; order Tinamiformes) Family of medium-sized, dumpy birds which have brown and grey, cryptically patterned plumage. Their bills are short to long and slightly decurved; they have longish necks; short, rounded wings; and very short tails. Their legs are strong and short to long; and they are terrestrial, preferring to run rather than fly. They inhabit forest, brush, and grassland; feed on fruit and seeds; and nest on the ground. There are nine genera, with 46 species, found in C. and S. America.

Tinamiformes (tinamous; class Aves) Order of birds which comprises the single family Tinamidae.

tinamous *See Cryptellurus*; and Tinamidae.

Tinca tinca (tench) *See* Cyprinidae.

tinder fungus Common name for the fruit bodies of *Fomes fomentarius*. These are hoof-shaped; the upper surface is pale brown or greyish-brown with concentric furrows, while the tubes on the underside are pale becoming brown. The spore print is white. In Britain tinder fungus is found on birch trees and occurs only in Scotland; in N. Europe and the USA it is common on beech and other trees.

tinea *See* ringworm.

Tineidae (clothes moths; order Lepidoptera) Very large family of small, generally drab moths, the classification and definition of the family being unclear. Most larvae feed on dried organic matter, and some are case-bearers. The family includes pests of carpets, clothes, and foodstuffs, and has a worldwide distribution.

Tingidae (lacebugs; order Hemiptera, suborder Heteroptera) Family of plant-feeding bugs in which the pronotum and forewings are covered with raised reticulations, often forming fantastic and intricate

shapes. Some species cause galls to form on their host plants. They are found throughout the world.

tin pyrites *See* stannite.

tinstone *See* cassiterite.

Tintinnida (subclass Spirotrichia) Order of ciliate protozoa in which the cell body is housed in a shell or lorica. Oral cilia are conspicuous and extend from the lorica. They are found in marine environments.

Tiphiidae (suborder Apocrita, superfamily Scolioidea) Family of often shining black, brownish, or black and yellow wasps in which the adults are 10–25 mm long, and have two posterior lobes on the mesosternum, or have rather strongly constricted wasp waists. Some subfamilies contain species with wingless females, a character associated with a fossorial habit. All are parasites of the larvae of Coleoptera and Hymenoptera, some specializing on Cicindellidae (tiger beetles). Both sexes feed on nectar and honeydew, and some are nocturnal. More than one egg per host may be laid. The family is fairly common and widely distributed.

Tipulidae (craneflies, daddy-long-legs, leatherjackets; class Insecta, order Diptera, suborder Nematocera) Family of true flies in which the adults have long, six-segmented antennae. The legs are long and are readily discarded if trapped. The mesonotum has a V-shaped suture on the dorsum. The distal cell is present in the wing venation. The female ovipositor is prominent and sclerotized. The larvae are metapneustic and live among soil or roots, or are aquatic. They are phytophagous or predacious. The family includes garden pests (leatherjackets) which destroy plant roots. The family has a worldwide distribution, and at least 13 500 species are known.

tissue Group of cells of similar type working in a co-ordinated manner towards a common function. They are normally bound together by their cell walls (in plants) or by an intercellular substance (in animals). Some fluids, e.g. blood, are also considered to be tissues.

titanite *See* sphene.

titanothere *See* Brontotheriidae.

titmouse *See* tits.

tits **1** *See* Paridae; and *Parus*. **2** (bushtits, long-tailed tits, pygmy tits) *See* Aegithalidae. **3** (penduline tits) *See* Remizidae. **4** (titwarblers, *Leptopoecile*) *See* Regulidae. **5** (wrentit, *Chamaea fasciata*) *See* Chamaeidae.

titwarblers (*Leptopoecile*) *See* Regulidae.

T_m **1** Temperature of melting. **2** Transport maximum, i.e. the maximum ability of the kidney to reabsorb or secrete a particular substance.

Tmesipteris (family Psilotaceae) Primitive cryptogamic vascular plant which (unlike *Psilotum*, the other genus of the family) has strap-shaped, pointed, one-veined leaves, and its sporangia fused in pairs on to a pair of bracts; like *Psilotum* it has no roots, only rhizoids on its rhizomes. The genus is of great interest for its probable relationship to the most ancient vascular plants known, the Psilophytaceae of Devonian times, such as *Rhynia* and *Hornea*. There are probably only two species, confined to Australasia and some Pacific islands.

toadfish *See* Batrachoididae.

toads **1** *See* Anurans; Bufonidae; Discoglossidae; Peodytidae; and Pipidae. **2** (Mexican burrowing toad) *See* Rhinophrynidae. **3** (spadefoot toads) *See* Pelobatidae.

toadstool Loose term for any umbrella-shaped fungal fruit body, or for any such fruit body that is inedible or poisonous.

tobacco (*Nicotinia tabacum*) *See Nicotinia*.

tobacco mosaic Disease of tobacco, tomato, and related plants, in which the leaves become distorted and are marked with a characteristic mosaic of light and dark green. It is caused by an RNA-containing virus, the tobacco-mosaic virus.

tobacco-necrosis virus RNA-containing virus which can infect a wide range of plants; symptoms of infection range from small leaf lesions to necrosis of the entire plant. It can be transmitted by the soil fungus *Olpidium brassicae*.

tobacco rattle Disease which occurs in tobacco, tomato, potato, and other plants. Symptoms vary with the nature of the plant infected. The causal agent is a virus which consists of two entirely separate particles, both of which must be present in the plant for replication of the complete virus to occur.

Tockus (hornbills; family Bucerotidae) Genus of mainly black, grey, and brown hornbills, which have red, yellow, or grey bills, some with casques. They inhabit forest, feed on fruit and insects, and nest in holes in trees. There are 15 species, found in Africa and S. Asia.

tocopherol Vitamin E; one of a group of fat-soluble terpene compounds that function as anti-oxidants in cells. They are required for the normal growth and fertility of animals.

toddy **1** Palm wine, prepared by fermenting the sugary exudate of young, bruised inflorescences of several palms, especially *Borassus* and *Cocos*. *See also Nypa*. **2** Mixture of spirits and water, sweetened and spiced.

Todea (family Osmundaceae) Genus of primitive ferns, which, with *Osmunda*, has certain features that are intermediate between the ancient eusporangiate and the modern leptosporangiate ferns; more than one initial cell may contribute to the formation of each sporangium and more than 500 spores may be produced in each one, but the sporangia are stalked. *Todea* produces its thick-stalked sporangia on the undersurface of the fronds only, and not aggregated into sori, while in *Osmunda* the sporangia are borne in marginal clusters on certain pinnae. There is only one species, confined to S. Africa and Australasia.

Todidae (todies; order Coraciiformes) Family which comprises the single genus *Todus*.

todies *See* Coraciiformes; and *Todus*.

Todus (todies; family Todidae) Genus of small birds which have green upper-parts, red throats, and pink or yellow flanks. They have long, fairly narrow bills, with red lower mandibles. They have large heads, short necks, and rounded bodies. Their wings are short and rounded, their tails medium-length, and their legs slender, with long, syndactyl toes. They inhabit forests and bush, feed on insects and fruit, and nest in holes in banks. There are five species, confined to the W. Indies.

Togaviridae Family of viruses in which the genome is single-stranded RNA; virions are enveloped. They can infect mammals, birds, and arthropods, and are transmitted from host to host by mosquitoes or ticks. The family includes the causal agents of some important diseases, e.g. yellow fever.

tokay gecko *See Gekko gecko*.

tolerance, limits of *See* limits of tolerance.

Tolypothrix (order Nostocales) Genus of filamentous cyanobacteria in which the filaments show 'false branching' due to broken ends of trichomes protruding through the sheaths. Heterocysts are present. Species are found in aquatic environments attached to other aquatic plants or to rocks.

tombolo Spit that links an island to the mainland or to another island, formed by deposition when waves are refracted round the island.

tomentose Woolly; covered with a fine mesh of hairs.

tomentum Mat of fine hairs which gives a woolly appearance to certain fungal structures, lichen thalli, etc.

tonguefish *See* Cynoglossidae.

tonguesole *See* Cynoglossidae.

tonhäutchens *See* cutan.

tonofilament Aggregation of filaments approximately 0.7–0.8 nm in diameter that occurs in large numbers in certain epithelial cells. Tonofilaments are particularly conspicuous in areas immediately beneath desmosomal plaques, which apparently they help to anchor to the cell cytoplasm.

tonoplast The membrane around a vacuole.

tonsillitis Inflammation of the tonsils, commonly caused by *Streptococcus pyogenes*.

tool use The use by an animal of an object external to itself and not attached to any substrate, that is held, carried, or otherwise manipulated in order to achieve an objective.

Toona (family Meliaceae) Genus of deciduous or semi-deciduous trees with pinnate leaves which are similar to *Cedrela* but whose flowers have a flattish disc, and the petals and stamens partly free. Some yield valuable timber (e.g. Australia cedar and Burma cedar). There are six poorly defined species, occurring from India to Australia.

tooth carp *See* Cyprinodontidae.

toothed flounder *See* Psettodidae.

toothed herring *See* Hiodontidae.

toothed whales *See* Odontoceti.

toothed wrack *See* serrated wrack.

tooth shells *See* Scaphopoda.

topaz Mineral, specific gravity 3.5–3.6, hardness 8.0, and which has the chemical composition $Al_2SiO_4(O,H,F)_2$, named after Topazos Island in the Red Sea. It typically occurs in granite pegmatites, rhyolite, and quartz veins; is found extensively as an accessory mineral in granites, associated with fluorite, tourmaline, beryl, and cassiterite; and also occurs in alluvial deposits. It is distinguished by its hardness, perfect basal cleavage, and high specific gravity. It can be colourless, pale yellow, pale blue, yellowish, or sometimes pink, is transparent, and has a vitreous lustre. It crystallizes in the orthorhombic system. The crystals are prismatic and often bipyramidal with the vertical faces striated, but it can also be massive and granular. Fine crystals are used as gemstones.

tope (*Galeorhinus galeus*) *See* nictitating membrane.

topogenous mire (topogenous peat) Type of bog that forms under climatic conditions of reduced rainfall with consequent lower humidity, and summer drought, which restrict the growth of *Sphagnum* to areas where precipitation is concentrated, e.g. valley bottoms.

topogenous peat *See* topogenous mire.

toposequence Sequence of soils in which distinctive soil characteristics are related to topographic situation.

topsoil 1 The superficial layer of soil moved in cultivation. 2 The A horizon of a soil profile. 3 Any surface layer of soil.

tor Mass of exposed bedrock, standing abruptly above its surroundings, and typically but not exclusively developed on granitic rocks. It may be formed by selective subsurface weathering followed by removal of the weathered debris, by differential frost-shattering, or as an end-product of scarp retreat under semi-arid conditions.

torbernite Secondary mineral, specific gravity 3.2, hardness 2.5, and with the chemical composition $Cu(UO_2)_2(SO_4)_2.8–12H_2O$. It occurs in the oxidized zones of veins containing uranium and copper minerals, and often with autunite. It is distinguished by its green colour and lustre. It is normally bright emerald-green, but occasionally it can be dark green, and it has a pale green streak, and a vitreous lustre. It crystallizes in the tetragonal system. The crystals are tabular, square, foliated, scaly aggregates.

tornado Relatively small-scale (about 100 m diameter) 'twisting' or rotating column of air, like a funnel, with high wind speeds and great destructive force over the narrow path of its movement. Such systems are especially frequent in unstable air conditions in the central parts of the USA.

Torpedinidae (electric ray, numbfish; class Chondrichthyes, subclass Elasmobranchii, order Rajiformes) Family of marine rays which have a

rounded outline, a stout trunk with a short tail-fin, and a soft skin. The eyes are small or rudimentary; the spineless two dorsal fins are well developed. All members of the family possess a pair of powerful electric organs derived from the branchial musculature and capable of delivering very unpleasant electric shocks to anyone treading on them. *Torpedo nobiliana* (Atlantic torpedo), 1.8 m, is one of the larger species of electric rays. There are about 35 species, distributed worldwide in coastal regions.

Torpedo nobiliana (Atlantic torpedo) *See* Torpedinidae.

torrent catfish *See* Amblycipitidae.

Torreya (nutmeg tree; family Taxaceae) Genus of conifers which differs from *Taxus* in its ovules, which develop into plum-like, hard seeds with a green, purple-striped aril, and its stiff, spine-tipped leaves. There are six species, occurring in the USA, China, and Japan.

torrid zone General climatic term for the region between the northern and southern tropics, broadly the 'equatorial' zone.

torsion In Gastropoda, the twisting of the body through 180 degrees so that the digestive and nervous systems have a U-shape and the mantle cavity, anus, gills, and two nephridiopores occupy an anterior position behind the head.

tortoise beetle *See* Chrysomelidae.

tortoises 1 *See* Chelonia; and Testudinidae. 2 (European pond tortoise) *See Emys orbicularis*. 3 (Galápagos giant tortoise) *See Testudo elephantropus*. 4 (gopher tortoise) *See Gopherus polyphemus*. 5 (Greek tortoise, Hermann's tortoise) *See Testudo hermanni*. 6 (pancake tortoise) *See Malacochersus tornieri*. 7 (Seychelles giant tortoise) *See Testudo gigantea*. 8 (spur-thighed tortoise) *See Testudo graeca*.

tortrices *See* Torticidae.

Tortricidae (tortrices, bell moths, leaf-rollers, fruit moths; order Lepidoptera) Large family of small moths with broad wings, which often resemble a bell in shape when they are at rest. The labial palps are porrect (stretched out). The larvae feed on litter, between leaves that they sew together, in fruit, or in galls. Some roll leaves. Many are pests, including the codling moth, whose larvae feed on apples. The family is distributed worldwide.

Tortula (order Pottiales) Genus of mosses which form greenish, sometimes hoary patches or cushions. The leaf nerve is usually excurrent. Capsules are erect, ellipsoid or cylindrical, straight or slightly curved, with a beaked lid. There are about 280 species, found mainly in temperate regions. *T. muralis* is common on brick and stone walls throughout Britain, even in towns. The leaves are broadly tongue-shaped, and the nerve extends well beyond the leaf tip to form a long hair point. *T. ruraliformis* (*T. ruralis* ssp. *ruraliformis*) often forms extensive carpets on sand-dunes; when moist the plants are orange-brown or golden-green in colour.

Torymidae (chalcid seed flies; suborder Apocrita, superfamily Chalcidoidea) Family of small to medium (2–13 mm long), elongate, usually metallic green, yellow, or black, chalcidoid wasps whose ovipositors may be as long as or longer than the body, and whose hind coxae and femora may be enlarged. Most are parasitic on dipteran and hymenopteran gall formers, although some eat seeds. The eggs are laid in galls or the seeds of trees, particularly conifers, and some are laid in caterpillars and mantid oothecae.

totara *See Podocarpus totara*.

totipalmate In birds, applied to feet which have all four toes joined by webs, a characteristic of the Pelecaniformes.

toucans *See* Piciformes; *Pteroglossus*; and Ramphastidae.

touch-me-nots (*Impatiens*) *See* Balsaminaceae.

touracos See Cuculiformes; Musophagidae; and *Tauraco*.

tourmaline A mineral, specific gravity 3.0–3.2, hardness 7, and with the chemical composition $Na(Mg,Fe,Li,Al,Mn)_3Al_3(BO_3)_3Si_6O_{18}(O,H,F)_4$. It commonly occurs in pegmatites, granites, and in sediments near granites, and as an accessory mineral in schists and gneisses. It is also found in lodes associated with high-temperature minerals, e.g. cassiterite and wolframite. It is distinguished by the prismatic habit of the crystals, their striated faces, and triangular cross-section. It is normally black to bluish-black, but it can be colourless, blue, pink, or green, and it has a vitreous lustre. It crystallizes in the trigonal system. The crystals are usually prismatic with a curved, triangular cross-section, and the crystal faces strongly striated. The attractively coloured varieties are used as semi-precious stones.

tourquoise *See* turquoise.

toxaemia Condition in which toxins, commonly bacterial toxins, are present in the blood.

toxicyst In certain protozoa, an organelle which resembles a trichocyst but in which the filament carries a poison that can kill other protozoa. Toxicysts are used for capturing prey.

toxin Microbial product which is poisonous to animals or plants. The symptoms of many types of human disease are due to the production of one or more toxins by the pathogen (*see* for example tetanus and diphtheria). Toxins usually act at specific sites in the body, e.g. neurotoxins affect nerves, enterotoxins affect the gut.

Toxoplasma (suborder Eimeriina) Genus of protozoa, which are parasitic in many species of animals and birds, living inside the cells of the host. They can cause the disease known as toxoplasmosis.

toxoplasmosis Disease of humans or other animals caused by the protozoon *Toxoplasma gondii*. Although a very wide range of animals can be infected by *T. gondii*, overt symptoms of disease are not common. When they do occur the symptoms are variable; death may occur rapidly if the lungs or brain become involved.

Toxostoma (thrashers; family Mimidae) Genus of grey-brown birds, some of which have black-spotted under-parts. They have short, rounded wings, and long tails. Their bills are medium to long, and slightly to very decurved. They are terrestrial, inhabit dense scrub or low trees, feed on invertebrates and fruit, and nest in low bushes. There are 10 species, some migratory, found in N. America and Mexico.

Toxotes chatareus (archerfish) *See* Toxotidae.

Toxotidae (archerfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine and freshwater fish with a deep, oval body, the dorsal and large anal fins being situated well to the back of the fish. The mouth and eyes are large. *Toxotes chatareus* (archerfish), 24 cm, of SE Asia and N. Australia, is capable of squirting a jet of water from its mouth and 'shooting down' insects from a height of up to 1.5 m above the water surface. There are about four species, in SE Asia.

trabelucae Pillars of radiating, calcareous fibres of microscopic size, which build up the skeletal elements in corals.

trace element *See* essential element.

trachea 1 Vessel; a tube-like series of non-living cells in the xylem of a plant, supplying mechanical support and involved in the transport of water and salts. 2 One of the cuticular tubes that make up the respiratory system of an insect. The tracheae ramify throughout the body, terminating in fine, intracellular branches (tracheoles). *See* spiracle. 3 In air-breathing vertebrates, the 'windpipe', leading from the throat and dividing into two bronchii, which enter the lungs.

tracheal gill (caudal gill) One of the three terminal gills that are present in the larvae of most damselflies. These are richly supplied with tracheae and are the main site of gas exchange. They are readily autotomized, however, being replaced slowly in later instars.

tracheole *See* trachea.

Tracheophyta (vascular plants; kingdom Metaphyta) Division comprising plants that have vascular tissues (xylem and phloem) through which water and nutrients are transported. In many modern classifications this division embraces the former divisions Pteridophyta and Spermatophyta.

Trachichthodes affinis (nannygai) *See* Berycidae.

Trachichthyidae (roughy, slimehead; class Osteichthyes, subclass Actinopterygii, order Beryciformes) Small family of marine fish which have a deep and compressed body, an oblique mouth, and a slender tail with a forked tail-fin. The head is large and bears slime glands in the skin, but the belly feels rough due to the presence of a series of scutes between the pelvic and anal fins. Some species are offshore fish; others, e.g. *Trachichthys australis* (southern roughy), 15 cm, are near-shore reef-dwellers. There are about 14 species, distributed worldwide.

Trachichthys australis (southern roughy) *See* Trachichthyidae.

Trachinidae (weeverfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine, bottom-dwelling fish which have an elongate body, a large oblique mouth, and the eyes situated on top of the head. The short, spiny-rayed, dorsal fin is separated from the long-based, soft-rayed, dorsal fin by a distinct notch. All weeverfish, including *Trachinus draco* (greater weeverfish), 40 cm, possess poison glands at the base of the spiny dorsal rays as well as on the spine of the gill cover. These spines can inflict painful wounds. There are four species, distributed in the E. Atlantic.

Trachinus draco (greater weeverfish) *See* Trachinidae.

Trachipteridae (ribbonfish, dealfish; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Small family of marine fish which have a much compressed body, gradually tapering to a very thin tail with a small tail-fin. The mouth is small, but the eyes are large. Typical is the very long dorsal fin, originating on the head and continuing to the tip of the tail; the anal fin is absent. Probably living at depths of 200–1000 m, *Trachipterus altivelis* (ribbonfish, or king-of-the-salmon) of the Pacific may reach a length of about 2 m. There are seven species, distributed worldwide.

Trachipterus altivelis (ribbonfish, king-of-the-salmon) *See* Trachipteridae.

trachoma Chronic disease of the human eye which is probably the greatest single worldwide cause of loss of sight. It is caused by *Chlamydia trachomatis* (once believed to be a virus). Initially, inflammation of the surface of the eye causes blurring of vision, and this may be followed by scarring of the cornea which may lead to total blindness. The disease is commonest in India, the Middle East, and parts of Africa.

Trachurus trachurus (Atlantic scad) *See* Carangidae.

trachyandesite *See* andesite.

Trachycarpus (family Palmae) Genus of palms several of which are in cultivation and are very hardy. The trunk is usually single. The leaves are fan-like, the flowers hermaphrodite, with three free carpels. *T. fortunei* (chusan or windmill palm) is hardy outdoors in Britain. There are four species, occurring in subtropical E. Asia from the Himalayas to Japan.

Trachylina (trachyline medusae, Trachylinida; class Hydrozoa) Order of Cnidaria having no fixed hydroid stage and a mobile medusoid stage that is well developed. Marginal sense organs are formed from modified tentacles and derived from the gastrodermis.

Trachylinida *See* Trachylina.

Trachymedusina (order Trachylina) Suborder of Cnidaria in which tentacles arise on the margin of

the umbrella, and gonads are situated on the radial canals.

Trachypsammiaceae (subclass Octocorallia) Extinct order of octocorals, found only in Permian rocks, which differs from related orders by the presence of a central medullar canal system from which new corallites of the dendroid colony originate, and of skeletal structures of the outer cortical region that are orientated radially.

trachyte Fine-grained volcanic rock of the alkaline series of intermediate rocks. Trachyte is the volcanic equivalent of syenite.

trachytic texture General petrographic term applied to volcanic rocks that have a fine mat of orientated feldspar laths, suggestive of flow.

traction load *See* bedload.

Tradescantia (spiderplant, wandering jew) *See* Commelinaceae.

trade-wind inversion The inversion of temperature lapse rate with height over a major zone of the trade-wind belt, which is very significant in tropical meteorology. Moist tropical air, extending up to 2–3 km above the surface, is 'boxed in' or 'trapped' by dry, clear, warmer air above, resulting from subsidence in subtropical anticyclones. The inversion forms where the subsiding air meets a surface flow of cooler maritime air. The top of a cloud layer marks the base of the inversion.

trade winds Old maritime term, much used in meteorology, indicating the steadiness of direction of the prevailing tropical easterly winds, which blow from subtropical high pressure areas in latitudes 30–40° north and south, generally north-easterly in the northern hemisphere and south-easterly in the southern hemisphere. They are most nearly constant in latitudes centred on 15° north and south. Climatic conditions associated with the belt vary from fine anticyclonic weather in the poleward and eastern margins, caused by subsidence, to stormier conditions near the equator and western margins caused by less stable, deeper, moist air.

Tragedy of the Commons Based on *Two Lectures on the Checks to Population* (W. F. Lloyd, published in 1833), the title of an essay by G. Hardin (*Science*, Vol. 162, 1968) in which it is argued that freedom to use the commons (i.e. common resources) will lead inevitably to their depletion. The argument is illustrated by the example of common grazing, used by herdsmen each of whom increases his economic return by increasing the size of his herd, until the pasture is overgrazed and degraded. The conclusion is that resources can be conserved only by constraints agreed by society as a whole and enforced.

Tragopogon porrifolius (salsify) *See* Compositae.

Tragulidae (chevrotains; order Artiodactyla, suborder Ruminantia, infra-order Pecora, superfamily Traguloidea) Family of pecorans which exhibit certain relatively primitive features. The family appears in the fossil record in the early Miocene. They are derived from the Hypertragulidae, the ancestral pecorans, which range from the Upper Eocene to the Lower Miocene. Although ruminants, the subdivisions of the stomach are less complex than in other pecorans. Horns are absent. The upper incisors are absent, as in other pecorans, but the upper canines are large, especially in the male, and form tusks. The tibia and fibula are fused, but the fibula is not reduced. There are four digits on each limb, which are complete although small. The cannon bone, formed by the fusion of the middle metapodials of all limbs and characteristic of higher pecorans, is complete in the hind limbs but only partial in the forelimbs of the Asian genus and absent in the forelimbs of the African genus. Chevrotains are small animals found in the forests of tropical Africa and Asia. There are four species in two genera, *Tragulus* (Asian) and *Hyemoschus* (African).

Traguloidea (order Artiodactyla, suborder Ruminantia, infra-order Pecora) Superfamily comprising the Tragulidae and the extinct families Hypertragulidae, Protoceratidae, and Gelocidae, primitive pecorans which lived between the Eocene and Pliocene. The hypertragulids lived mainly in N. America, and departed from the general form in the development of a lower premolar which functioned as a canine. The protoceratids, also from N. America, shared this feature but had longer faces and horns. The gelocids lived in the Old World during the Oligocene and may have been transitional forms directly ancestral to the modern pecorans.

tragus In Mammalia, a flap developed from the lobe extending in front of the external opening of the ear.

trait Any detectable phenotypic property of an organism; a character.

trama Fungal tissue that supports a hymenium, e.g. the sterile tissue of the gill of an agaric.

Trametes (family Polyporaceae) Genus of fungi which form bracket-like fruit bodies. There are about 20 species. A number of fungi formerly included in this genus (e.g. *Coriolus versicolor*, and *Lenzites betuli*) have been transferred to other genera.

tramontana Local wind in the Mediterranean which brings dry, cold conditions from the north across the mountains.

tramp species Species that have been spread around the world inadvertently by human commerce.

transaminase (aminotransferase) Enzyme that catalyses a transamination reaction.

transamination The transfer of an amino group from an amino acid to a keto acid in a reaction catalysed by a transaminase. This is the principal method in cells for the synthesis of non-essential amino acids, and requires a pyridosal or pyridoxamine phosphate as a coenzyme.

transcellular streaming Movement of constituents of the protoplasm through linear files of longitudinally orientated plant cells.

transcription The polymerization of ribonucleotides into a strand of RNA in a sequence complementary to that of a single strand of DNA. By this means the genetic information contained in the latter is faithfully matched in the former. The process is mediated by a DNA-dependent RNA polymerase.

transduction Transfer of bacterial genetic material from one bacterium to another via a phage. The genetic material of one bacterial cell becomes incorporated into phage particles which, after release from the dead host cell, then act as vectors carrying it to other bacterial cells.

transect (isonome) Linear vegetation sampling method most commonly used to investigate an environmental gradient, e.g. of salinity in a salt-marsh. Generally a line is drawn across the vegetation zoning and recordings are made at intervals along its length.

transferase Enzyme that catalyses the transfer of a functional group from one substance to another.

transfer cell Type of cell found in higher plants, with a great abundance of protruberances in the wall and many plasmodesmata, which enhance solute movements. These cells are found in association with cells of the phloem and xylem.

transfer ribonucleic acid (transfer-RNA, tRNA) Generic term for a group of small RNA molecules, each composed of 70–80 nucleotides arranged in a clover-leaf pattern stabilized by hydrogen bonding. They are responsible for binding amino acids and transferring these to the ribosomes during the synthesis of a polypeptide (i.e. during translation). At the ribosomes, which are attached to the messenger-RNA (mRNA), the 'reading frame' indicates the three mRNA nucleotides that form the next triplet codon in the sequence: whichever tRNA molecule carries the complementary anticodon can associate with the ribosome such that the amino acid that it bears can be joined on to the end of the growing polypeptide.

transfer-RNA *See* transfer ribonucleic acid.

transform fault A strike-slip fault which occurs at the boundary of lithospheric plates, either at an oceanic ridge or at a subduction zone.

transglycosylation Mechanism for glycosidic bond formation, particularly during polysaccharide synthesis. Nucleoside phosphate derivatives act as 'activated' donor compounds in which the energies of their glycosidic bonds are partially conserved in the reaction products. Glycosides cannot be synthesized spontaneously from free monosaccharides owing to the high negative free energy ($-\Delta G$) of the hydrolysis reaction.

transgression (geol.) The retrograding of sediments (on-lap) where sequences of sediments reflect a vertical change from deeper water to shallow water, e.g. where shelf mud is deposited on coastal sand. *See* regression.

transient polymorphism The presence in a population at a particular gene locus of alternative alleles in which one is progressively replaced by another, in contrast to a balanced polymorphism where the alleles are at equilibrium with each other.

transition In genetics, a type of mutation (a nucleotide-pair substitution) that involves the replacement in DNA or RNA of one purine with another, or of one pyrimidine with another. An example is the change of GC (guanine–cytosine) to AT (adenine–thymine).

translation The polymerization of amino acids into a polypeptide chain whose structure is determined genetically. This process occurs on a ribosome and involves several small proteins, mRNA, and tRNA. The sequence of amino acids in the chain is specified by that of the nucleotides in the mRNA (these being read as codons, i.e. in groups of three), and this in turn follows the sequence of nucleotides in the DNA.

translocation 1 The movement of dissolved substances within a plant, usually from the site of synthesis or uptake to centres of growth or storage. 2 A change in the arrangement of genetic material, altering the location of a chromosome segment. The most common forms of translocations are reciprocal, involving the exchange of chromosome segments between two non-homologous chromosomes. A chromosomal segment may also move to a new location within the same chromosome or in a different chromosome, without reciprocal exchange; these kinds of translocations are sometimes called transpositions. 3 The movement of soil materials in solution or in suspension from one horizon to another.

translucidus From the Latin *translucidus* meaning 'transparent', a variety of cloud, occurring in extensive layers or sheet form, which is translucent, allowing the Sun or Moon, and occasionally some stars, to be visible. This characteristic can be presented by stratus, stratocumulus, altostratus, and altocumulus. *See also* cloud classification.

transmutation The transformation of one element into another by radioactive decay. The term is also sometimes used for the change of one species or type to another.

transparency Degree to which a substance allows radiation of varying wavelengths to pass through, as opposed to absorbing it. *See also* absorption.

transpiration The removal of moisture from the soil by plant roots, its translocation up the stem to the leaves, and its evaporation through the stomata. The flow of water through the plant is known as the transpiration stream. It reduces leaf temperatures and is thought to be important for mineral absorption and translocation within plants. The process imposes a number of environmental requirements upon plants; for example, wilting and desiccation result from an insufficient supply of water.

transpiration stream *See* transpiration.

transposable elements Chromosomal loci that may be transposed from one spot to another within and among the chromosomes of the complement. The process occurs through breakage on either side of

these loci and their subsequent insertion into a new point either on the same or a different chromosome.

transposition *See* translocation.

transverse dune *See* dune.

transverse process One of the pair of lateral projections at each side of the neural arch of a tetrapod vertebra with which the rib articulates.

transverse tubular system *See* T-system.

trapdoor spiders (order Araneae, suborder Mygalomorphae) Spiders of the families Antrodiaetidae, Actinopodidae, and Ctenizidae, which have three tarsal claws and a rastellum (a special row of spines used for digging) on the chelicerae. Most species are 3 cm long and live in a silk-lined tube dug into the ground, with a silk lid. Passing insects are attacked and pulled into the tube with great rapidity, and the tubes are enlarged as the spiders grow. Trapdoor spiders are found in the Americas, Africa, and Australia.

traveller's palm (*Ravenala madagascariensis*) *See Ravenala*.

Trebouxia (family Chlorococcaceae, order Chlorococcales) Genus of unicellular, non-motile green algae which are the commonest phycobionts in lichens. Phycobiont cells show some differences from their free-living counterparts, e.g. in the proportion of photosynthetic products formed, and in the amount of such products released from the cells (greater in the phycobiont). Free-living *Trebouxia* cells are found on trees, fences, etc.

tree-borer *See* increment borer.

treecreepers *See Certhia*; and Certhiidae.

tree crickets *See* Gryllidae.

tree frogs *See* Hylidae.

tree hopper *See* Membracidae.

tree line *See* baumgrenze.

tree lungwort Common name for the lichen *Lobaria pulmonaria*. The thallus is broadly lobed; the upper surface is bright green when wet but pale greenish-grey when dry, while the lower surface is brown, and marked with a network of short, dark brown hairs. The main habitat is ancient woodland, hence it is now rare in most parts of Britain, although it is still fairly common in parts of the west and in Scotland. This lichen was used extensively in folk medicine for treating various lung disorders, owing to its fancied resemblance to a lung.

tree mallow (*Lavatera arborea*) *See Lavatera*.

treenail Thin, cylindrical piece of wood that is used to secure the planking to the timbers of a ship.

tree partridge *See Arborophila*.

tree porcupine (*Coendou*) *See* Erethizontidae.

tree-ring (annual ring, growth ring) Sheath of cells appearing as one of a series of concentric rings in the cross-section of a woody stem. Each ring is usually the result of a single yearly growth flush starting in spring and ceasing in late summer. The new wood (xylem) cells arise from renewed activity of the vascular cambium. A sharp boundary usually occurs between the rings since cells formed in spring are typically large, and thin-walled, and appear pale in colour when compared with the small, thick-walled cells of late summer. In some dicotyledonous species vessel distribution also varies, with most vessels occurring in the early (spring) wood. These ring-porous species contrast with ring-diffuse species in which the vessels are distributed evenly throughout the growth ring. The growth check that causes variable cambial activity may be temperature or water stress or both. In some extreme environments growth may not always be renewed on an annual basis, leading to absent rings ('missing years') and false rings (multiple rings in the same year). Dating by tree rings is difficult in these circumstances. *See also* dendrochronology; vascular cambium; vessel; tracheid; and xylem.

tree-ring analysis *See* dendrochronology; dendroclimatology; and dendroecology.

tree-ring index An annual tree-ring width that has been standardized for age. Most dendrochronological work is based on tree-ring indices or standardized series, rather than on the original ring widths.

tree shrew *See* Tupaiidae.

tree swift *See* Apodiformes; and Hemiprocnidae.

tree veld S. African grassland with an open or light cover of trees which gives it a parkland aspect. It is thought that in the absence of fire much, if not all, of the veld would develop into forest or scrub.

Tremadocian Oldest of the six 'stages' that comprise the Ordovician Period. Mudstones and sandstones of the Tremadoc Series occur in N. America, Ireland, Wales, England, and Scandinavia. They mark the shelf and slope areas that occur on the southern edge of the N. Iapetus Ocean.

Tremandraceae Family of small shrubs in which the leaves are simple, often narrow, opposite or alternate, and without stipules. Occasionally the shrubs are glandular and have winged stems. The flowers are often very brightly coloured, usually red or purple. They are regular, bisexual, solitary, and axillary, with 3–5 sepals and petals. There are twice as many stamens as petals. The ovary is superior, of two fused carpels with a single style. The fruit is a capsule which slits open along the locule partitions. The seeds contain copious endosperm and are occasionally hairy. The family is related to the Pittosporaceae and Polygonaceae. Some species are cultivated as ornamentals. There are three genera, with 43 species, within the family, all of them confined to Australia.

Tremella (family Tremellaceae, order Tremellales) Large genus of fungi, in which the fruit body is gelatinous (or absent in some parasitic species) and is typically convoluted or cushion-like. Most species are saprotrophic for example on wood, but some are parasitic on the fruit bodies of other fungi.

Tremellales (subclass Phragmobasidiomycetidae) Order of fungi in which the basidia are divided

longitudinally by septa. Fruit bodies are typically gelatinous when wet, cartilaginous when dry. They are mostly saprotrophic, usually growing on wood. There are many genera.

tremolite Mineral, specific gravity 2.9–3.0, hardness 5.5–6.0, and with the chemical composition $Ca_2Mg_5(Si_4O_{11})_2(OH)_2$, named after the Tremala Valley near St Gotthard, Switzerland. It is a widespread amphibole mineral in igneous rocks, and is also found in metamorphosed, crystalline limestones, dolomites, and in schists and hornfels. It is distinguished by its light, white to greyish-white colour, and it has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are simple, long, prismatic, and acicular in form, often in thin, radial, rod-like, fibrous, and felted masses.

trencher maker Person who makes carved boards, wooden bowls, plates, etc.

trench fever Disease of humans caused by the rickettsia *Rochalimaea quintana*. Symptoms include pain, malaise, and fever. The pathogen is transmitted by lice.

trench mouth *See* Vincent's angina.

trend surface analysis Special case of multiple regression analysis, in which the independent variables are spatial co-ordinates. This enables assessment of spatial trend in data values. The technique is used, in particular, in geographical studies.

Trentepohlia (family Trentepohliaceae, order Ulotrichales) Genus of algae in which the thallus is typically bright orange and minutely filamentous, resembling orange velvet to the naked eye. It is found on rocks, leaves, tree bark, etc.; also as phycobiont in certain lichens.

Treponema (family Spirochaetaceae, order Spirochaetales) Genus of flexible, spirally-shaped bacteria which are anaerobic chemo-organotrophs. There are many species, found in the alimentary and reproductive tracts in humans and other animals. Some species are pathogenic, e.g. *T. pallidum* is the causal agent of syphilis.

Trepostomata (subphylum Ectoprocta, class Gymnolaemata) Order of bryozoans, in which the colony is solidly built of calcite, of variable form. Individuals possess long tubes, divided by numerous partitions. Each individual is divisible into two regions: a thin-walled, proximal, immature area, and a mature, distal area in which the walls are thick and the partitions closely spaced. The order is Palaeozoic, from the Ordovician to Permian.

Treron (green pigeons; family Columbidae) Genus of mainly bright green pigeons, some of which have yellow, orange, and mauve markings. They are stocky, and most have short tails. They are arboreal, inhabit forests, scrub, and open country, and feed on figs; their gizzards can grind up the seeds that are ingested. They nest in trees and shrubs. There are 23 species, found in Africa, S. Asia, and Indonesia.

trevalla *See* Centrolophidae.

trevally *See* Carangidae.

Triacanthidae (triplespine, tripodfish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Small family of marine, tropical fish which have a deep and compressed body, a small mouth, two dorsal fins, and a narrow caudal peduncle. The first dorsal fin spine and the two pectoral spines are capable of being locked firmly in an upright position when the fish is threatened. *Triacanthus brevirostris* (shortnosed tripodfish), 24 cm, is fairly common in inshore and estuarine waters. There are about seven species, distributed in the Indo-Pacific region.

Triacanthodidae (spikefish; class Osteichthyes, subclass Actinopterygii, order Tetraodontiformes) Small family of marine tropical to subtropical fish, closely related to the Triacanthidae (tripodfish), but with fewer finrays, a rounded tail-fin, a pointed snout, and large eyes. There are about 19 species, distributed in the Indo-Pacific region and the W. Atlantic.

Triacanthus brevirostris (shortnosed tripodfish) *See* Triacanthidae.

triad *See* crystal symmetry.

Triakidae *See* Carcharhinidae.

triallelic Applied to a polyploid in which three different alleles exist at a given locus.

Triassic The earliest of the three periods of the Mesozoic Era, which began 225 million years ago and lasted 40 million years. As a result of the mass extinctions of the late Palaeozoic, Triassic communities contained many new faunal and floral elements. Among these were the ammonites, modern corals, various molluscs, the dinosaurs, and certain gymnosperms.

Triassochelys quenstedii *See Proganochelys quenstedii.*

tricarboxylic-acid cycle *See* citric-acid cycle.

Trichastoma (*Malacocincla*, jungle babblers; family Timaliidae) Genus of small, uniform, brown babblers, which have fairly stout bills, with hooked tips and rictal bristles. They have short wings, and fairly short to very short tails. They inhabit forests, feed on insects, and build ball-like nests in trees or bushes. There are 18 or 19 species, found in Africa, SE Asia, and Indonesia.

Trichechidae (manatees; cohort Ferungulata, superorder Paenungulata, order Sirenia) Family of aquatic paenungulates in which the upper lip is deeply cleft and each side is capable of independent movement and is used for cropping vegetation. There are no incisors or canines, but the gums form horny pads. There are up to 20 cheek teeth which are peg-like and fall out when worn, probably without being replaced. The tail is unnotched. Manatees occur in coastal waters and rivers in tropical and subtropical America and W. Africa. There are three species in a single genus, *Trichechus*.

trichiation *See* chaetotaxy.

Trichiuridae (cutlassfish, hairtail; class Osteichthyes, subclass Actinopterygii, order Perciformes)

Small family of marine fish with a very elongate, slender body, the tail tapering to a point or provided with a tiny, forked tail-fin. The large mouth has strong, fang-like teeth. The dorsal fin is extremely long, but the other fins are poorly developed. Most species inhabit the upper few hundred metres of the ocean and can be hooked on a line; sometimes they are caught by trawlers. There are about 17 species, e.g. *Trichiurus savala* (E. Australian hairtail), 1.8 m, distributed worldwide in tropical and temperate seas.

Trichiurus savala (E. Australian hairtail) *See* Trichiuridae.

trichocyst Organelle that, on appropriate stimulation, explosively extrudes a thread-like filament. Its function is unknown. Trichocysts are found in certain types of protozoa.

Trichodectes canis (dog louse) *See* Trichodectidae.

Trichodectidae (order Phthiraptera, suborder Ischnocera) Family of chewing lice which are parasitic on placental mammals. Members of the family are distinguished from other Ischnocera by the presence of only one antennal flagellomere in all males and most females, two or more hook-like setae on the antennal flagellum of most males, lateral abdominal tergal pits in males, and only one tarsal claw on each leg. *Trichodectes canis* (dog louse) transmits tapeworms between dogs but otherwise members of the family are not known to be vectors of disease. Trichodectidae parasitic on sheep, goats, cattle, and dogs cause irritation by their biting, and the efforts of the host to dislodge them can lead to loss of hair. There are 20 genera, with about 350 species, distributed worldwide.

Trichoderma (class Hyphomycetes) Form-genus of fungi in which conidia are produced in phialids; the walls of the conidia are slimy, and masses of the spores stick together at the tip of the phialid. Some species have perfect states in the Hypocreaceae.

Trichodesmium (order Nostocales) Genus of filamentous cyanobacteria in which the filaments occur in masses embedded in a flocculent mucilage. Species are unusual among cyanobacteria in that they are planktonic, often forming a major component of the plankton in tropical seas. They are capable of nitrogen fixation. Heterocysts are not formed. Gas vacuoles allow the colonies to float, and when seas are calm they form conspicuous surface blooms ('sea sawdust') measuring up to several kilometres across.

Trichodontidae (sandfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have a large head, a large, upward-directed mouth with fringed lips, and two dorsal fins. The anal fin is long and the pectorals well developed. *Trichodon trichodon* (Pacific sandfish), 31 cm, is thought to bury its body in the sand, awaiting the arrival of potential prey. Locally important as food fish, the two species of sandfish occur only in the N. Pacific basin.

Trichodon trichodon (Pacific sandfish) *See* Trichodontidae.

trichogen cell Epithelial cell beneath the cuticle which secretes a cuticular hair. In many insects these hairs are sensory, and contain nerve endings.

Trichogrammatidae (suborder Apocrita, superfamily Chalcidoidea) Family of chalcidoids which is unique in having three-segmented tarsi. Apart from a few wingless females found in figs, all are egg parasites attacking a wide range of hosts, some being very valuable as biological-control agents. Adults are minute (often less than 1 mm long), fringe-winged wasps with greatly reduced venation. Most parasitize the eggs of Lepidoptera, although some attack eggs of water beetles and water bugs, using their tiny wings to swim down to reach their hosts.

Tricholoma (family Tricholomataceae) Genus of fungi which form mushroom-shaped fruit bodies; the stipe is fleshy and central, and the gills are only narrowly attached to the stipe. The spore print is white or pale pink; the spores are smooth and do not stain dark violet when treated with iodine. There are many species, found on the ground, mostly in woodland. *See also* blewit.

Tricholomataceae (order Agaricales) Family of fungi which form white or pale-coloured spores in fruit bodies which typically bear gills, and may or may not be stipitate. There are many genera. They are mainly saprotrophic, but some are parasitic in woody plants.

Trichomanes (bristle-ferns; family Hymenophyllaceae) Genus of filmy ferns that differs from *Hymenophyllum* in the cylindrical or bell-shaped indusium surrounding each marginal, gradate sorus, and in its filamentous (not flat as in *Hymenophyllum*) gametophytes. The tip of the soral placenta eventually projects as a bristle from the indusium. In the wide sense there are some 330 species, but some authors divide the genus into many smaller genera. The plants occur throughout most tropical zones, with a few outliers in mild, moist, temperate zones (e.g. *T. radicans*, Killarney bristle-fern, found in western parts of the British Isles).

Trichomanes radicans (Killarney bristle-fern) *See Trichomanes*.

trichome In certain bacteria and cyanobacteria, a chain of vegetative cells; a cyanobacterial trichome is often surrounded by a slimy sheath.

Trichomonadida (class Zoomastigophorea) Order of protozoa which are not bilaterally symmetrical and which have 4–6 flagella. The cells swim with a jerky motion. There are several families. Most are harmless parasites which live in the intestinal or reproductive systems of vertebrates.

Trichomonas (order Trichomonadida) Genus of protozoa which includes both commensal and pathogenic species. *T. vaginalis* parasitizes the human genito-urinary tract and can cause vaginitis. *T. foetus* can cause abortion in cattle.

Trichomycteridae (parasitic catfish; class Osteichthyes, subclass Actinopterygii, order Siluriformes) Large family of freshwater fish, which tend to have

a slender, pencil-shaped body with a scaleless skin, small fins, and two pairs of barbels above the mouth. Many species, e.g. *Pygidium itatiaye* (15 cm), may hide in the river bottom or in leaf-litter during the day, but attack other animals at night to feed on blood and tissues. There are about 185 species occurring in C. and S. America.

Trichonotidae (sand diver; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine fish which have an elongate, thin body, a pointed snout, and long-based second dorsal and anal fins. The spines of the first dorsal fin may be rather long. Sand divers are found on the sea-bottom, but tend to disappear into the mud very quickly when disturbed. There are about 19 species, occurring in tropical to subtropical seas.

Trichonympha (order Hypermastigida) Genus of protozoa which live symbiotically in the gut of termites and other insects. *T. campanula* is a bell-shaped organism. Numerous cells of this species pack the intestine of the termite *Zootermopsis* and seem to be responsible for the digestion of the wood eaten by the termite.

Trichophyton (class Hyphomycetes) Form-genus of fungi which occur either as saprotrophs (e.g. in soil), or as parasites of animals and humans, causing diseases of the skin, hair, or nails. Some species have perfect states classified in the Eurotiales.

Trichospermum (family Tiliaceae) Genus of trees which have flattish sprays of leaves, fibrous bark, and twigs with stipule scars. The flowers are held in cymes, and are pentamerous. The fruit is capsular. There are 20 species, occurring from the Nicobar Islands to the W. Pacific.

Trichostomatida (class Ciliatea) Order of ciliate protozoa characterized by the structure of the cytostome region. At this region there is a ciliated depression which leads into a buccal cavity lacking cilia, and at the base of which occurs the cytostome. Trichostomatida are found in freshwater habitats. Some are parasitic in the intestines of animals.

Tricladida (planarians; class Turbellaria, subclass Neoophora) Order of platyhelminth worms which have a divided intestine and a pharynx. All are free-living.

triconodont Applied to a tooth, typical of primitive mammals, that has three simple, conical cusps.

Triconodonta (class Mammalia, subclass Prototheria) Order that includes the earliest of all mammals, living from the late Triassic until the early Cretaceous and distributed over the northern continents. Typically the molar teeth each had a row of three sharp conical cusps, the teeth of the upper and lower jaws forming a shearing device. Premolars and molars were differentiated, probably with some replacement, and probably the young were fed on milk secreted by the mothers. Trichodonta may have been homoiotherms and nocturnal, and possibly they were arboreal. They are believed to have been true carnivores rather than insectivores. *Triconodon* was the size of a modern cat. The order is believed to have evolved from therapsids independently of the main line of mammalian evolution and to have left no descendants.

Tridactylidae (pygmy mole crickets; order Orthoptera, suborder Caelifera) Small family of minute, smooth, shiny caeliferans which are usually found on the ground or in burrows, usually near lakes or streams. The hind legs have much enlarged femora, and are used in jumping and swimming, but not in walking. The insects probably feed on algae and other vegetable matter in the soil. About 50 species are known, four of which are Mediterranean in distribution. The genus *Tridactylus* is cosmopolitan.

Trifolium (clovers; family Leguminosae) Genus of annual or perennial herbs, with leaves that are trifoliate, stalked, and with stipules adnate to their stalks. The flowers usually are in dense, racemose heads, with short stalks or none. The petals are persistent, and the pods very small, short, and indehiscent, remaining enclosed in the calyx, and often also by the standard petal. The genus includes many important fodder plants (especially *T. repens* and *T. pratense*) and, like other Leguminosae, fixes nitrogen by means of root-nodule bacteria, so increasing soil fertility. There are some 290 species, centred in S. Europe and W. Asia but extending to other temperate and tropical regions.

triggerfish *See* Balistidae.

trigger plants *See Stylidium*; and Stylidiaceae.

Trigla lucerna (yellow gurnard) *See* Triglidae.

Triglidae (gurnard; class Osteichthyes, subclass Actinopterygii, order Scorpaeniformes) Family of marine fish with a large, armoured head, two separate dorsal fins, and, typically, large pectoral fins in which the lower three rays are enlarged and free from the fin membrane. These separate rays are used as feelers for the detection of food. Several species, including *Trigla lucerna* (yellow gurnard), 65 cm, of the E. Atlantic, show brilliant colour patterns on the body as well as on the pectoral fins; some species are considered commercially important. There are about 85 species, distributed worldwide in temperate and tropical seas.

Triglochin (arrow-grass) *See* Juncaginaceae.

Trigona (stingless bees) *See* Apidae; and honeybee.

Trigonella (fenugreek, foenugreek; family Leguminosae) Genus of annual herbs with toothed, trifoliate leaves. The flowers are blue, yellow, or whitish, solitary or in clusters, and small and pea-like (*see Pisum*); they develop into slender, curved pods up to 15 cm long. *T. foenum-graecum* is widely cultivated. The fresh plant is eaten as a vegetable, and the seeds are used in curry, chutney, and flavourings. Fenugreek is grown as a fodder crop in N. Africa. Most species are from the Mediterranean region and Asia.

Trigoniaceae Family of forest trees and shrubs, closely related to Polygalaceae, in which the leaves are simple with small stipules. The flowers are zygomorphic, with five sepals, three or five petals, 3–12 stamens, on one side, and the ovary superior with three locules. The fruit is a capsule. There are four genera, with 35 species, occurring in Madagascar, W. Malesia, and tropical America.

Trigonioida (phylum Mollusca, class Pelecypoda) Order of equivalved pelecypods which have ovate or trigonal shells. Their dentition consists of well-developed, schizodont teeth, and the ligament is short, external, and opisthodetic. They have small, isomyarian adductor muscles, and normally an entire pallial line. They first appeared in the Devonian, but were most common in the Mesozoic.

trigonous Triangular in cross-section.

Trilliaceae Family of monocotyledonous herbs, close to Liliaceae, but with erect, simple stems bearing leaves in an opposite pair, or in a single whorl near the summit of the stem, and having reticulate veining, unusual in monocotyledons. The flowers are terminal, usually solitary, or sometimes in a small umbel, with free sepals and petals each in one whorl, and with the parts in either threes or fours. The number of stamens is equal to that of the perianth segments; the ovary is superior, and usually one-celled. The fruit is a berry or a fleshy capsule. There are four genera, with about 25 species, in the northern temperate zone. *Paris*, found in Europe and temperate Asia, has flower parts in fours; *Trillium*, of N. America, has them in threes.

trilobite A member of the fossil subphylum Trilobitomorpha.

Trilobitomorpha (trilobites; phylum Arthropoda) The most primitive arthropod subphylum (or in some classifications a phylum, where the Arthropoda rank as a superphylum), known from more than 3900 fossil species. Inhabitants of Palaeozoic seas, the trilobites appeared first in the early Cambrian, had their widest distribution and greatest diversity in the Cambrian and Ordovician Periods, and became extinct in the Permian. The body was divided into three regions: an anterior cephalon, comprising at least five, fused segments; a mid-body or thorax, with a varying number of segments; and a hind region or pygidium. All three regions were divided by a pair of furrows running the length of the body, giving a trilobite appearance (i.e. a median or axial lobe, flanked on either side by a lateral lobe). The mouth was situated in the middle of the central surface of the cephalon. Paired gill-bearing limbs were attached to the membranaceous, pleural skeleton. X-ray studies show the eyes to have resembled the compound eyes of living arthropods. Trilobites ranged in size from 0.5 mm long planktonic forms to those nearly 1 m in length; most species were 3–10 cm long.

Trimenoponidae (order Phthiraptera, suborder Amblycera) Family of chewing lice which are parasitic on caviomorph rodents and marsupials in S. America. Members of the family are distinguished from other Amblycera by the contraction of the first abdominal tergal plate, the reduction or absence of the first pleural plate, the loss of the spiracles on abdominal segment VIII, and the presence of two tarsal claws on each leg (the last character being unusual in mammal lice). There are six genera, with 10 species.

trimeric *See* dimer.

trimerous Of a flower, with parts in threes, as in most monocotyledons.

tri-nerved Of a leaf, with three main nerves.

Tringa (sandpipers; family Scolopacidae) Genus of medium-sized waders which have longish bills, straight in most species, but in some slightly recurved. Their legs are medium to long, and distinctly coloured in many species. In flight most species show white on the tail and rump. They inhabit coastal and inland waters and wet meadows, feed on invertebrates, and nest on the ground or in trees. There are 11 species, most migratory, found worldwide.

Triodia (family Gramineae) Genus of coarse grasses which are similar in superficial appearance to *Spinifex* and are commonly known as such. They form tussocks, usually 50 cm in height and 0.5–1 m wide. The leaves are softly hairy on the sheath and edges, but hairless at the apex. They are strongly nerved, with needle-like, rigid blades. The flower panicle is usually loose and nodding. There are 35 species, all endemic to Australia where they are components of grassland and shrub communities, but they have little agricultural value. *T. basedowii* (lobed spinifex) is the most common grass of the central Australian grassland communities on sand plains.

Triodia basedowii (lobed spinifex) *See Triodia*.

Trionychidae (soft-shelled turtles; order Chelonia (Testudines), suborder Cryptodira) Family of highly aquatic turtles occurring in fresh, brackish, and occasionally sea water. The bony shell is regressed, and covered with vascularized, respiratory skin. The head has a proboscis and fleshy lips. The limbs are oar-like. There are 25 species, occurring in N. America, Asia, and Africa.

triplespine *See* Triacanthidae.

tripletail *See* Lobotidae.

triploblastic Applied to animals in which the body wall has three layers.

Triplochiton scleroxylon (family Sterculiaceae) Fast-growing W. African tree with a valuable, much exported timber (obeche) which nowadays is extensively planted.

triploid Applied to a cell with three sets ($3n$) of chromosomes in its nucleus, or to an organism composed of such cells (as opposed for example to haploid (n) or diploid ($2n$) cells or organisms). *See also* polyploidy.

tripodfish *See* Triacanthidae.

Tripterygiidae (black-faced blenny; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of small, blenny-like fish which are easily recognized by the presence of three dorsal fins, the first two having spiny rays. The tail-fin is rounded, the anal fin is rather long, and the pelvics are reduced to a few free rays. There are distinct differences between the colour patterns of the sexes, only the males showing a black face. Members of the family, e.g. *Trypterygion tryperonotus* (black-faced blenny), 8 cm, of the Mediterranean, tend to inhabit the rocky shores and

coral reefs of tropical and subtropical seas. There are about 95 species, distributed worldwide.

Tripterygion tripteronotus (black-faced blenny) *See* Tripterygiidae.

triquetrous Of a stem, for example, triangular in cross-section with a sharp angle at each corner.

trisomic Applied to a genome that is diploid but that contains an extra chromosome, homologous with one of the existing pairs, so that one kind of chromosome is present in triplicate. The chromosome number is thus of the form $2n + 1$. Trisomies give multiple doses of genes and may have deleterious effects, as in the human condition of Down's syndrome, which results from a trisomy of chromosome 21.

Tristania (family Myrtaceae) Genus of trees, often with scroll-like bark, in which the leaves are spirally arranged. The flowers have five fused sepals, five petals, and five bundles of stamens, and the ovary is semi-inferior. The fruit is a capsule. *Tristania* species yield useful timber. There are 50 species, occurring from Malesia to the Pacific islands.

Trithurieae *See* Centrolepidaceae.

Tritonia *Crocosmia* × *crocosmiflora* (*Tritonia* × *crosmiflora* of *Flora Europaea*), is a garden hybrid (*T. aurea* × *T. pottsii*) 'lily' (family Iridaceae) of gladiolus-like habit, with erect spikes of deep orange, funnel-shaped flowers of nearly regular shape. It is much cultivated and has become naturalized (from the corms thrown out of gardens) in oceanic temperate areas.

Triturus cristatus (great crested newt, warty newt; order Urodela (Caudata), family Salamandridae) Newt in which the skin is warty. The back is mottled blackish-brown, the belly is orange-yellow with black spots. The male develops a high, serrated, breeding crest. It is the largest British newt (up to 18 cm) and has a widespread distribution across C. Europe to the Urals.

Triturus helveticus (palmate newt; order Urodela (Caudata), family Salamandridae) Newt which has a mottled, olive-brown back, and a yellow to white under-surface. The male has webbed hind feet, and a low, smooth, breeding crest ending in a thread-like extension of the tail. The female grows to about 9 cm; the male is smaller. *T. helveticus* occurs in Britain and parts of C. Europe.

Triturus marmoratus (marbled newt; order Urodela (Caudata), family Salamandridae) Large newt (up to 15 cm long) which spends much of its time in water. Its body is green with black marbling. The male develops black and yellow breeding crests, which are represented in the female by a red dorsal line. It occurs in Spain, Portugal, and France.

Triturus vulgaris (smooth newt; order Urodela (Caudata), family Salamandridae) Newt in which the skin is smooth or finely granulated, and olive-brown with darker spots and stripes above, a spotted orange belly, and a white throat. The male develops a serrated breeding crest along the back and tail. Its maximum length is 10 cm. It is the common newt of Britain, and its range extends across Europe into Siberia.

triungulin larva In some parasitic insects, an active first larval instar that hatches in the soil but that has three claws at the end of each of its legs, enabling it to climb a plant where it awaits its insect host. Some Meloidae (oil beetles) produce triungulin larvae.

Triuridaceae Monocotyledonous family of small, tropical herbs which are always saprophytic. The plants lack photosynthetic pigments and their leaves are reduced to scales distributed along the colourless or reddish stem. The regular flowers are either dioecious or monoecious, and unisexual or bisexual, and are borne in racemes. There are up to 10 perianth segments held in series, which are equal or unequal; in some species a tuft of hair is present in the tip of the segment. The 2–6 stamens are free, sometimes with some infertile stamens in the separate male or female flowers. In the male flowers there may be three fertile stamens and three staminodes. After flowering the segments reflex. The female flowers often have staminodes. The ovary is superior with free, unfused, uni-ovular carpels which each have a single style. The fruit is a dense mass containing the seeds, which have an oily, white endosperm. There are seven genera, with 80 species, present in all the tropical regions of the world.

tRNA *See* transfer ribonucleic acid.

trochantellus An additional segment in the legs of Hymenoptera which occurs between the trochanter and the femur, from which it is thought to be derived.

trochanter The second joint of the leg of an insect, which articulates with the coxa proximally and with the femur distally. The trochanter is a small segment and can usually move in only one plane (due to the nature of its articulation with the coxa). Odonata and Hymenoptera have two trochanters, but the distal one appears to be derived from the femur. *See also* trochantellus.

Trochilidae (hummingbirds; order Apodiformes) Family of small, mainly green, black, or brown birds which have areas of brightly coloured, iridescent plumage on the throat, crown, head, and back. They have slender and pointed, short to long bills, which are straight or decurved. Their wings are long and narrow; their tails rounded, square, or forked; and some tail feathers are elongated or modified. Their legs are short, with small feet. They are arboreal, inhabit forests, and feed on nectar and insects. Their flight is very rapid and they hover when feeding. They nest in trees. There are about 115 genera, with about 330 species, many migratory, found in N., C., and S. America, and in the W. Indies. *Mellisuga helenae* (bee hummingbird), measuring about 5 cm from the tip of its bill to the end of its tail, is the smallest bird in the world.

Trochodendraceae (order Trochodendrales) Family of evergreen Asian forest trees containing a single species, *Trochodendron aralioides*. The tree

has leaves that are alternate, apparently whorled, diamond-shaped, and glossy, with long stalks. The tiny green flowers have no perianth, and are borne in inflorescences at the ends of branches. The fruits are follicles. The family has the 'primitive' feature of having no vessels. Birdlime is made from the bark.

trochophore In several invertebrates, a ciliated, usually planktonic larva.

Troglodytes (wrens; family Troglodytidae) Genus of small, brown wrens which have pale supercilia and barred wings and tails. They inhabit forests, scrub, and gardens; feed on insects and spiders; and build domed or cup-shaped nests in tree cavities or buildings. There are five species, found in Europe, Asia, and N., C., and S. America. *T. troglodytes* (wren, winter wren) is the only member of the family found in Europe or Asia.

Troglodytes troglodytes (wren, winter wren) *See Troglodytes*.

Troglodytidae (wrens; order Passeriformes) Family of small to medium-sized birds which have brown plumage, some with white and chestnut areas. Their wings, tails, and sides are often barred, streaked, or spotted. Their bills are slender, medium to long, and slightly decurved; their wings are short and rounded; and their tails are short to long, and often held cocked. Their legs and feet are strong, with long claws. They inhabit forests, brush, reedbeds, rocks, and deserts; feed on insects and spiders; and most build domed nests in trees or rock cavities, or low in grass or bushes. There are 15 genera, with 60–5 species, found in Europe, Asia, and N., C., and S. America.

Trogon (trogons; family Trogonidae) Genus of medium-sized tropical birds which have metallic green backs; green or blue heads and throats; and red, orange, or yellow breasts. The under-side of the tail has distinctive black and white markings. They inhabit forests, feed on insects and fruit, and nest in tree cavities. There are 15 species, found in C. and S. America.

Trogonidae (trogons; order Trogoniformes) Family of medium to large birds which have bright green or brown backs; green, blue, or violet heads and throats; and pink, red, orange, or yellow breasts. They have rounded wings, and most have long, square-ended tails. *Pharomacrus mocino* (resplendent quetzal) has very elongated upper tail coverts. Trogons' bills are broad, with a curved culmen. Their legs are short, with the first and second toes directed backwards. They are arboreal, inhabit forests and clearings, and feed on insects and fruit, fluttering in front of a leaf to pick off food. They nest in tree cavities and holes in termite nests. There are eight genera, with 37 species, found in Africa, Asia, and C. and S. America.

Trogoniformes (trogons; class Aves) Order which consists of the single family Trogonidae.

trogons *See Harpactes*; *Trogon*; and Trogonidae.

Tropaeolum (family Tropaeolaceae) Genus of dicotyledonous herbs, often succulent. Many species climb by means of twining leaf stalks. The leaves may be entire or palmately lobed, with long stalks. The flowers are showy, with five irregular petals, and five sepals forming a spur below. *T majus* is the nasturtium, a common garden ornamental from S. America, once cultivated as a salad plant. There are about 90 species, from C. and S. America.

trophic level A step in the transfer of food or energy within a chain. There may be several trophic levels within a system, for example producers (autotrophs), primary consumers (herbivores), and secondary consumers (carnivores); further carnivores may form fourth and fifth levels. There are rarely more than five levels since usually by this stage the amount of food or energy is greatly reduced. *See also* ecosystem.

trophoblast *See* blastocyst; and chorion.

trophozoite In Sporozoa, the feeding stage that develops from the sporozoite.

tropical air Air masses whose characteristics originate from a tropical source. Broadly, these comprise: (a) maritime tropical air, originating over oceans; and (b) continental tropical air, originating over land masses, and especially over N. Africa and the Middle East. Movements of these air masses poleward, with modification of their original characteristics, can have marked influence on weather in mid latitudes.

tropical cyclone (revolving storm) A generally fairly small but intense, closed low-pressure system which develops over tropical oceans. Wind speeds of at least 33 m/s (force 12 on the Beaufort scale, 64 knots or more) define such storms and distinguish them from less intense systems, e.g. tropical depressions (of twice or more than twice the diameter), or tropical storms. The atmospheric pressure gradient in such cyclones commonly ranges from about 950 mb at the centre to about 1000 mb at the margins.

tropical forest Category of vegetation comprising a variety of formation types including rain forest, semi-evergreen seasonal forest including monsoon forest, and deciduous seasonal forest.

tropical montane forest Typically, a forest of short trees 10–12 m high in a single stratum, their trunks and boughs being misshapen and covered in mosses, lichens, and liverworts. This is the 'mossy forest' which coincides with the belts of mist and cloud at heights of 2000–3000 m. If the montane forest persists above the cloud zone, as it does in New Guinea, for example, then the trees are taller and the 'mosses' less in evidence.

tropical rain forest The most prolific, productive, and oldest of all the world vegetation types, which occurs in the equatorial lowlands and is characterized by up to three tree strata, and a profusion of lianas, epiphytes, and saprophytes. The trees are evergreen and flowering, and fruiting and leafing continue all year.

tropical seasonal forest Tropical forest that grows in regions with a marked dry season. There is some defoliation during the dry season, the degree depending on the severity of the moisture deficit.

The structure of the forest is also simpler than that of the rain forest, with fewer tree strata, and less luxuriant growths of climbing and herbaceous plants.

tropicbirds *See* Pelecaniformes; and Phaethontidae.

tropic movement *See* tropism.

tropism (tropic movement) Directional response by a plant to a stimulus. It may be positive or negative (i.e. toward or away from the source of the stimulus). The plant may respond by growth or turgor changes so that parts of it bend towards, away from, or at right angles to the direction of the stimulus. The suffix '-tropism' is used in relation to responses to particular stimuli, e.g. 'phototropism' is a response to light, 'geotropism' to gravity, and 'chemotropism' to a chemical substance.

tropomyosin Highly elongated protein of relative molecular mass 70 000 composed of two alpha-helix sub-units wound about each other. It is associated *in vivo* with actin and troponin in the thin filaments of striated muscle.

troponin Globular protein associated *in vivo* with actin and tropomyosin in the thin filaments of striated muscle.

tropopause Boundary separating a lower layer of the atmosphere (troposphere), in which air temperature generally decreases with height, from the layer above (stratosphere), in which temperature remains constant or increases with height. The altitude of the tropopause varies from an average of 10–12 km over the poles (occasionally descending to 8 km or below) to 17 km over the equator, according to season, and changes over short periods. *See also* atmospheric structure; and troposphere.

troposphere The layer of the atmosphere between the Earth's surface and the tropopause, within which the air temperature on average decreases with height at a rate of about 6.5 °C/km, though variations that sometimes occur include inversions (temperature increase with height within some limited layer). Most of the atmospheric turbulence and weather features occur in this layer, which contains almost all the atmospheric water vapour and most of the aerosols in suspension in the atmosphere (although there is also an important aerosol layer at about 22 km). *See also* atmospheric structure.

tropotaxis Movement of an animal in response to a stimulus directly toward or away from the source of the stimulus. It is made possible by the possession by the animal of more than one receptor so that the strength of a stimulus to either side of its body may be detected simultaneously and compared.

trough Extension of low pressure from the central regions of a low-pressure system into a zone where generally higher pressure prevails. The term 'trough' is also, and in accordance with this definition, applied to equatorward meanders of the flow of the upper westerly winds over middle latitudes. (The 'equatorial trough', where trade winds meet, is synonymous with the 'intertropical convergence zone'.) *See also* long wave.

troupial *See Icterus*.

trout *See* Salmonidae.

troutperch *See* Percopsidae.

trowal Canadian meteorological term for the line of the upper front of an occlusion and for the region about it where the warm air, having been lifted off the surface, is still relatively low. A trough or valley of warm air, still undergoing lifting, it is normally marked by clouds and precipitation.

true bugs *See* Hemiptera.

true flies *See* Diptera.

'true' frogs *See* Ranidae.

'true' fungi *See* Eumycota.

'true' mosses *See* Bryidae.

true water beetle *See* Dytiscidae.

truffle The underground fruiting body of certain species of *Tuber* (order Tuberales). Truffles are edible and highly esteemed. *T. aestivum* is 2–8 cm in diameter and has a dark brown, warty surface. The inside is greyish with a network of white veins. It is found in England in soil of beech woods. *T. melanosporum* (the Périgord truffle) occurs in S. Europe and resembles *T. aestivum* but is rather smaller (1–3 cm).

trumpetfish (flutemouth) *See* Aulostomidae.

trumpeters 1 *See* Latridae. 2 *See* Psophiidae.

trumpet vine *See Campsis*.

truncated spur Blunt-ended, sloping ridge which descends the flank of a valley. Its abrupt termination is normally due to erosion by a glacier which tends to follow a straighter course than the former river.

Tryblidioidea (phylum Mollusca, class Monoplacophora) Order of mainly oval monoplacophorans, fossil forms of which have several symmetrically paired muscle scars. Shells are often thick, and sometimes ornamented with concentric growth lines. Tryblidioidea first appeared in the Lower Cambrian.

Trypanorhyncha (Tetrarhynchidea; phylum Platyhelminthes, class Cestoda) Order of parasitic, platyhelminth worms in which the scolex has suckers and tentacles. Their life cycle is not well studied, but they are known to inhabit three hosts during their development.

Trypanosoma (family Trypanosomatidae) Genus of protozoa which are parasitic in a wide range of vertebrates. The parasites live in the circulatory system and tissue fluids of the host. There are six subgenera, and many species. Some cause important diseases, including sleeping sickness.

Trypanosomatidae (order Kinetoplastida) Family of parasitic protozoa in which the cells are extremely variable in form, depending on the host and the conditions. Species are parasitic in vertebrates, invertebrates, and plants.

trypanosomiasis Any disease of humans or other animals in which the causal agent is a protozoon of the genus *Trypanosoma*. *See*, for example, sleeping sickness.

Trypauchenidae (burrowing goby; class Osteichthyes, subclass Actinopterygii, order Perciformes) Small family of marine and freshwater fish with an eel-like, compressed body, a blunt head with minute eyes, and long dorsal and anal fins which are confluent with the tail-fin. They are usually found hidden in burrows in a muddy or gravelly sea-bottom in the warmer waters near Africa and in the Indo-Pacific region. There are about 10 species.

trypsin Proteinase (endopeptidase) enzyme that acts primarily on the interior bonds of proteins. It is produced in the pancreas as the inactive zymogen trypsinogen, which on secretion into the intestine is converted into the active form by the intestinal enzyme enterokinase.

tryptophan Heterocyclic, non-polar, alpha-amino acid.

T_s Symbol used to indicate the actual average temperature at the surface of the Earth, about 15 °C. *See also* effective temperature.

tsetse flies *See* Glossinidae.

Tsuga (hemlock firs; family Pinaceae) Genus of evergreen conifers, with narrow, oblong, flat, blunt, stalked leaves arranged spirally on the stems, but spreading laterally and usually unequal in length, with two white bands lengthwise beneath. The cones are small, rounded, and pendulous, with persistent scales and inconspicuous bracts. There are some 10 species, some native to temperate N. America, others to E. Asia. The genus includes several valuable timber trees, often grown commercially.

tsunami Seismic sea wave of long period produced by a submarine earthquake, underwater volcanic explosion, or massive gravity slide of sea-bed sediment. In the open ocean such waves are barely noticeable even though they may be travelling at 700 km/h, but on reaching shallow water they build up to heights of more than 30 m and cause enormous damage in coastal areas.

Tsutsugamushi disease *See* scrub typhus.

T-system (transverse tubular system) System of anastomosing tubular invaginations of the plasma membrane that run transversely across striated muscle cells and insinuate themselves between the myofibrils. They can undergo depolarization, and their function is to conduct impulses rapidly from the surface of the muscle cell to its interior.

tuatara (*Sphenodon punctatus*) *See* Sphenodontidae.

tuba From the Latin *tuba* meaning 'trumpet', a supplementary cloud feature of cumulonimbus or sometimes cumulus, characterized by a column or cone of cloud projecting from the cloud base. *See also* cloud classification.

tube-feet In Echinodermata, hollow appendages connected to the water-vascular system, used in some species for locomotion and in others for feeding.

tube-nucleus The vegetative nucleus (one of three nuclei in the male gametophyte) in the growing pollen tube of a flowering plant; it degenerates after double fertilization.

tuber In a plant, a swollen stem or root functioning as an underground storage organ. Stem tubers (in potatoes, for example) often produce buds along the stem from which aerial stems arise the following season. Root tubers produce no buds, or produce buds only at the point where the tuber is attached to the stem of the plant.

Tuberales (class Discomycetes) Order of fungi in which the fruit bodies usually occur underground. The hymenium is not exposed to the exterior, and spores appear to be dispersed by animals that eat the fruit bodies. There are four families, and many genera.

tubercle bacillus Any species of *Mycobacterium* that can cause tuberculosis, but particularly *M. tuberculosis*.

tuberculosis Infectious disease which affects humans and other animals. In humans the commonest form of the disease is pulmonary tuberculosis (consumption, phthisis); the causal agents are usually *Mycobacterium tuberculosis* or *M. bovis*. Infection occurs by inhalation of the pathogen, and lesions known as tubercles develop in the lungs. Tuberculous lesions may also develop in other areas of the body, e.g. the liver or the bones. In untreated cases the mortality rate may be very high. Domestic animals, particularly cattle and pigs, may also contract tuberculosis. Tuberculosis in cattle used to be very common in Britain, but is now much less so due to strict control measures; bovine tuberculosis is now a notifiable disease. Certain types of wild animals (especially badgers) can contract bovine tuberculosis and are believed to be able to transmit the infection to cattle; this has led to the extensive slaughter of badgers in certain areas of Britain.

tubeshoulder *See* Searsiidae.

Tuboidea (class Graptolithina) Extinct order of sessile, dendroid graptolites, with erect stipes. Stolothecae are not well developed or are restricted to an encrusting, basal attached area. Autothecae and bithecae are clearly present, but the budding pattern is very variable. Tuboidea are known from the Lower Ordovician to Middle Silurian. The order contains two families, with about 10 genera.

Tubularina *See* Gymnoblastina.

Tubulidentata (cohort Ferungulata, superorder Protoungulata) Order comprising the one family Orycteropodidae, with one surviving member, *Orycteropus afer* (aardvark or antbear), an isolated form with a skeleton similar to that of condylarths, for which reason it is included in the Protoungulata. Fossil forms are known from the Miocene of Africa and the Pliocene of Eurasia, and some Eocene and Oligocene material may also belong to this group. The order derives its name from the teeth, each of which consists of many hexagonal columns of

dentine separated by tubes of pulp. There are about 10 teeth in each jaw of the adult, but there is a full complement of milk teeth in juveniles. The teeth lack enamel. Although an ant-eater, the jaw of the aardvark is little reduced. The snout is long, the mouth round, and the tongue long. The back is highly curved. There are four digits on each forelimb and five on the hind limbs, with nails apparently intermediate between claws and hoofs, used for digging. The brain is small and primitive. The aardvark is about the size of a pig, feeds almost exclusively on ants and termites, and is distributed widely throughout Africa S. of the Sahara.

Tubulifera *See* Thysanoptera.

Tubuliporina (class Gymnolaemata, order Cyclostomata) Suborder of bryozoans, in which the colony is variable in overall form, and either encrusts hard substrates or stands erect. Members of the suborder display polyembryony (many larvae budding from a single embryo). The suborder occurs from the Ordovician to Recent.

tuco-tuco (*Ctenomys*) *See* Ctenomyidae.

tucuxi (*Sotalia*) *See* Stenidae.

tufa Sedimentary rock formed by the deposition or precipitation of calcium carbonate, or more rarely silica, as a thin layer around saline springs or the encrustations on stalactites and stalagmites.

tularaemia Disease which affects humans and certain other animals, particularly rodents. The causal agent is the bacterium *Francisella tularensis*. The disease may be acute or chronic, and typically begins with malaise, fever, and ulceration at the site of infection.

tulip *See Tulipa*.

Tulipa (tulip; family Liliaceae) Genus of bulbous herbs with large, erect, usually solitary, terminal flowers of cup or bell shape, with six similar perianth segments, and without nectaries. The stigma is three-lobed. There are some 50 species, in Europe, N. Africa, and temperate Asia. Many species and garden hybrids are cultivated for their fine flowers of varied colours. The garden tulip (*T. gesnerana*) was introduced to Europe from Turkey in the sixteenth century, which led to a craze, particularly in the Netherlands, for breeding and growing new forms.

tulip tree (*Liriodendron tulipifera*) *See Liriodendron*; *see also Spathodea*.

tullgren funnel Device used to extract small invertebrate animals from a dry soil sample. The sample is placed in a container with a base made from gauze with a mesh designed to hold soil particles but permit the animals to pass. The container is arranged over a funnel, with a light above. The heat causes the animals to move away from the top of the sample, through the gauze sheet and into the funnel from which they can be collected. Most species are collected after two hours, but complete extraction takes 2–3 days.

tumblebug *See* Scarabaeidae.

Tumbunan division Term coined by Schodde and Calaby (1972) to characterize New Guinean biota above about 1200 m altitude, and to include Australian rain forests (a) between Cooktown and Mackay, and (b) between Gympie and Illawarra, whose fauna is closely allied to that of the New Guinea highlands, and to contrast with the Irian division.

tumour Abnormal growth of new tissue that occurs anywhere in the body. Such a growth may be harmless or benign, e.g. a wart. Alternatively it may be malignant, destroying the tissue upon which it grows. It may also invade other tissues through the process of metastasis, in which cells sloughed off from the tumour are carried to other parts of the body. *See also* cancer cell.

tuna *See* Scombridae.

tundra Treeless plain of the arctic and antarctic regions characterized by a low, 'grassy' sward. Actually, although grasses are rarely absent, sedges (*Carex* species), rushes (*Juncus* species), and wood rushes (*Luzula* species) are the dominant plants, together with perennial herbs, dwarf woody plants, and various bryophytes and lichens.

Tundra Soil One of the Great Soil Groups, within suborder 1 of the order Zonal Soils of the 1949 USDA system of soil classification, based originally on the work of V. V. Dokuchaev, but now superseded by the USDA Soil Taxonomy in which Tundra Soils are classified as Inceptisols. They occur on ground that drains poorly (mainly because of permafrost), and are acid, are 30–60 cm deep, have a high content of organic matter at the surface, and have a microrelief formed by freezing and thawing; their formation, and the decomposition of organic matter, is inhibited by the low temperature.

tung oil *See Aleurites*.

Tupaiidae (tree shrews; order Insectivora, suborder (often ranked as an order) Scadentia) Family, suborder, or order of small, generally arboreal, somewhat squirrel-like mammals, which show characteristics resembling those of primates, with which some authorities still classify them, although it is now generally accepted that similarities to primates are illusory or convergent. The brain is relatively large, with a small olfactory region; a postorbital bar is present in some forms; the ears are small and rounded; the hallux is slightly opposable; and the digits bear claws. There are three lower incisors, procumbent and pressed together to form a lemur-like 'dental comb'. The cheek teeth are primitive. Tree shrews feed on insects and fruit, and are distributed throughout India and SE Asia. There are five genera, with about 15 species.

Tupinambis teguixin (common tegu, great tegu; order Squamata, suborder Sauria (Lacertilia), family Teiidae) Large, ground-living lizard which is squat-bodied, with a long tail. It grows up to 140 cm long; is black in colour, with bands of yellow spots; shelters in burrows; and feeds on small vertebrates, insects, worms, fruit, etc. It occurs in S. America from Guiana to Uruguay.

turbary (common of) The right to cut peat turves for fuel on common land.

Turbellaria (phylum Platyhelminthes) Class of platyhelminth worms, most of which are not parasites. The epidermis of most is ciliated. Almost all have a cavity for the gut.

turbidite Sedimentary deposit laid down by a turbidity current.

turbidity current A variety of density current that flows as a result of a density difference created by dispersed sediment within the body of the current. Such currents are initiated by the disturbance of sediments on a slope by strong wave action, earthquake shock, or slumping. Turbidity currents in the oceans are thought to move rapidly at speeds of up to 7 m/s, down the continental slope or submarine canyons along the sea-bed to deposit originally shallow-water sediments at the foot of the slope or on the abyssal plain. The ideal sequence of sediments laid down by a waning turbidity current is known as the Bouma sequence.

turbinal bones (turbinates) In Mammalia, delicate, scroll-like bones, covered with mucous membrane, situated in and subdividing the nasal cavity.

turbinate 1 Shaped like a top. 2 One of the turbinal bones.

turbot, European (*Scophthalmus maximus*) *See* Bothidae.

turbulence Disturbed flow in a moving stream of air, manifested by variations of wind speed and direction, including vertical components, and vertical exchanges of mass, heat, momentum, water vapour, and any pollutants present, by eddies.

turbulent boundary layer In the surface layers of the atmosphere, below 500 m, frictional effects from the surface create turbulence in the air above. Wind speed is reduced, particularly below 50 m height, and reaches zero at the boundary. The effects are significant in micrometeorology.

turbulent flow Mode of flow occurring in both air and water, and characterized by the superimposition of transverse movements, notably vortex behaviour, on the general downstream trend. Local upward movement brings about the lifting and removal of particles from stream beds and from the surface of a sandy area.

Turdidae (thrushes; order Passeriformes) Family of small to medium birds, most of which are brown, grey, black, olive, blue, or white, usually contrasting. They have medium-length, slender to stout bills, short and rounded to long and pointed wings, and short to long tails, some forked. Their legs are of medium length, and are 'booted' (have no scales). They are arboreal and terrestrial; inhabit forests, open country, deserts, and cultivated land; and feed on animal and vegetable matter. They nest in trees and bushes, on the ground, or in tree holes or rock cavities. There are about 50 genera, with about 312 species, found worldwide.

Turdoides (babblers; family Timaliidae) Genus of fairly large birds, which have uniform brown plumage, sometimes streaked. Their bills are slightly decurved, and their tails are long and graduated. They inhabit dry scrub, feed on berries and insects, and nest in trees and bushes. They have loud and melodious songs. There are 25 or 26 species, found in Africa and S. Asia.

Turdus (thrushes; family Turdidae) Genus of medium-sized, black, grey, or brown birds, some of which have black-spotted, white under-parts. They have stout bills, often orange or yellow, long wings, and medium-length tails. They inhabit forests, open areas, and gardens; feed on invertebrates and fruit; and nest in trees and rock crevices. There are about 63 species, found worldwide except for New Zealand, where *T. merula* (blackbird) and *T. philomelos* (song thrush) have been introduced.

Turdus merula (blackbird) *See Turdus*.

Turdus philomelos (song thrush) *See Turdus*.

turgor The rigidity of a plant and its cells and organs resulting from hydrostatic pressure exerted on the cell walls.

turgor pressure The hydrostatic pressure exerted by the vacuolar contents against the cell wall. It is equal to, but opposes, the wall pressure.

turkeys *See* Meleagrididae; and *Meleagris*.

turkey X disease Disease of turkeys, resulting from the ingestion of feedstuffs contaminated with aflatoxins produced by *Aspergillus* species. Symptoms include loss of appetite, weakness, and lesions in the liver; the mortality rate may be high.

turmeric *See Curcuma*; and Zingiberaceae.

Turner's syndrome *See* Barr body.

Turnicidae (buttonquails; order Gruiformes) Family of quail-like, brown birds, which have short, slender bills, short, rounded wings, and short tails. Their feet have only three toes, the hind toe being absent. They are terrestrial and secretive, inhabit grassland and open woodland, feed on seeds and insects, and nest on the ground. There are two genera, with 14 species, found in Europe, Africa, S. Asia, and Australasia.

turnip *See Brassica*.

turnover number Measure of enzyme activity, normally expressed as the number of moles of substrate transformed into one or more products per mole of enzyme.

turnover rate Measure of the movement of an element in a biogeochemical cycle. Turnover rate is calculated as the rate of flow into or out of a particular nutrient pool, divided by the quantity of nutrient in that pool. Thus it measures the importance of a particular nutrient flux in relation to the pool size. *Compare* turnover time.

turnover time Measure of the movement of an element in a biogeochemical cycle; the reciprocal of turnover rate. Turnover time is calculated by dividing the quantity of nutrient present in a particular nutrient pool or reservoir by the flux rate for that nutrient of element into or out of the pool. Turnover time thus describes the time it takes to fill or empty that particular nutrient reservoir. *Compare* turnover rate.

turpentine *See Pistacia*; and *Syncarpia*.

turquoise (tourquoise) Secondary mineral, specific gravity 2.7, hardness 5.5, chemical composition $CuAl_6(PO_4)_4(OH)_8.5H_2O$. It occurs in veins in association with aluminous, igneous, or sedimentary rocks that have undergone alteration. Finer varieties are used for semi-precious stones. It is distinguished by its blue colour. It is sky-blue to blue-green, and has a white or greenish streak, and a waxy lustre. It has a conchoidal fracture. It crystallizes in the triclinic system. Crystals are very rare; it normally occurs massive, granular to cryptocrystalline, or as encrusting masses.

Tursiops truncatus (bottle-nosed dolphin) *See* Delphinidae.

turtle doves *See Streptopelia*.

turtles 1 *See* Chelonia. 2 (big-headed turtles, *Platysternon megacephalum*) *See* Platysternidae. 3 (Carolina box turtle) *See Terrapene carolina*. 4 (common musk turtle) *See Sternotherus odoratus*. 5 (eastern box turtle) *See Terrapene carolina*. 6 (freshwater turtles) *See* Emydidae. 7 (green turtle) *See Chelonia mydas*. 8 (hawksbill turtle) *See Eretmochelys imbricata*. 9 (hidden-necked turtles) *See* Cryptodira; and Pelomedusidae. 10 (leatherback, leathery turtle, *Dermochelys coriacea*) *See* Dermochelidae. 11. (loggerhead turtle) *See Caretta caretta*. 12 (marine turtles) *See* Cheloniidae. 13 (matamara) *See Chelus fimbriatus*. 14 (mud turtles, musk turtles) *See* Kinosternidae; and *Sternotherus odoratus*. 15 (pitted-shell turtle, *Carettochelys insculpta*) *See* Carettochelyidae. 16 (side-necked turtles) *See* Pleurodira. 17 (snake-necked turtles) *See* Chelidae. 18 (snapping turtles) *See* Chelydridae. 19 (stinkpot) *See Sternotherus odoratus*. 20 (Tabasco turtles) *See* Dermatemydidae. 21 (terrapins) *See* Emydidae.

tusk shells *See* Scaphopoda.

tussock moths *See* Arctiidae; and Lymantriidae.

tuxuci *See* Stenidae.

twilight Period of half-light caused by scattering and reflection of sunlight in the upper atmosphere at a time when the Sun is some degrees below the horizon.

twinning (crystall.) Feature, common to many single crystals, that consists of the crystal lattice being differently orientated in two or more parts of the crystal.

twisted wrack *See* spiral wrack.

two-legged worm lizards *See Bipes*.

two-way table *See* contingency table.

two-winged flies *See* Diptera.

Tylopoda (order Artiodactyla, suborder Ruminantia) Infra-order comprising the Camelidae (camels and llamas) which are specialized remnants of a much larger group of ruminant-like artiodactyls known to have lived between the Eocene and early Pliocene, and which are also included in the infra-order, including the Old World families Anoplotheriidae, Cainotheriidae, Xiphodontidae, and Amphimerycidae, and the New World families Agriochoeridae, Merycoidodontidae, and Oromerycidae. The anoplotheres were stoutly built animals, about 90 cm high at the shoulder; the cainotheres were rabbit-like, in size and probably in habits; the xiphodonts were possibly close to the ancestral line leading to the camels; and the amphimerycids to the line leading to the pecorans. The New World forms were rather pig-like, although the agriochoeres had long tails and redeveloped claws, leading to suggestions that they were arboreal or that they dug for roots and tubers.

Tylosurus crocodilus (houndfish) *See* Belonidae.

tympanic bone In Mammalia, the bone supporting the tympanic membrane, derived from the angular bone of the lower jaw and, in many mammals, forming the bulla.

tympanic membrane The ear drum, a double layer of epidermis to either side of connective tissue which transmits sound waves to the middle ear.

type specimen (holotype) Individual plant or animal chosen by taxonomists to serve as the basis for naming and describing a new species or variety. *Compare* lectotype; and syntype.

Typha (reedmace; family Typhaceae) Genus of tall, stout, rhizomatous herbs which grow in shallow water. They are usually more than 2 m in height, with long, simple stems. The leaves arise from the base and are linear and elongated with a thick, spongy inner tissue, sheathing at the base. The unisexual flowers are numerous, and characteristically held on a terminal spadix which is club-shaped, with the female flowers below the male. The flowers are surrounded by slender hairs or scales, which are the petals and sepals. The 2–5 stamens are united. Each female floret has a unilocular ovary. The fruits are achenes which dry and split. The plant relies on wind pollination and wind dispersal. The leaves of *T. latifolia* (reedmace) are used as weaving material for baskets and mats. There are 10–20 species, found throughout shallow, freshwater habitats of temperate and tropical regions.

Typhaceae (reedmaces, catstails, (sometimes, incorrectly) bulrushes) Family of stout, monocotyledonous herbs, with rhizomes usually growing under water, and erect, unbranched stems with long, strap-like leaves rising mostly from the base. The flowers are tiny, but numerous, in a terminal, cylindrical spike. The lower part of this spike consists of close-packed female flowers, densely surrounded by hairs (which may represent the perianth), the upper part consists of male flowers with 2–5, often conjoined, stamens. The ovary is one-celled, and stalked. Species of *Typha* are important colonists of shallow, fresh water, where they help to consolidate muds. There is one genus, with 15 species, having an almost cosmopolitan distribution.

Typhlomys (Chinese pygmy dormouse) *See* Platacanthomyidae.

Typhlonectidae (typhlonectids; class Amphibia, order Apoda (Gymnophiona)) Family of caecilians that are aquatic throughout life. The tail is absent. There are no dermal scales. Reproduction is ovoviviparous. The gills are bag-like; the gill slits close before hatching. Typhlonectids' food consists

mainly of small aquatic vertebrates. There are 18 species, all S. American.

Typhlopidae (blind snakes; order Squamata, suborder Serpentes (Ophidia)) Family of primitive burrowing snakes. They have a small, rigid skull with teeth only on the upper jaw. The eyes lie beneath scales. The body is worm-like, with a short tail, often ending in a spine. A rudimentary pelvis is present. The scales are small (not enlarged ventrally). There are about 200 species, found in the Old and New Worlds, and Australia.

typhoid fever Acute disease of humans, caused by the bacterium *Salmonella typhi*. Infection occurs by ingestion of the pathogen, commonly in contaminated drinking water. The pathogen invades the lymphoid tissue of the small intestine. Symptoms include fever, skin rash, and diarrhoea or constipation. The disease can be fatal if untreated.

typhoon Tropical cyclone of great force which occurs in the W. Pacific Ocean. *See* hurricane.

typhus fevers Fevers that are caused by rickettsias. Classical (epidemic or louse-borne) typhus is an acute disease of humans caused by *Rickettsia prowazekii*. The infection is carried by lice. Symptoms include fever, muscular pains, headache, malaise, and later a rash. Similar diseases are caused by other species of *Rickettsia—see* for example, murine typhus; and scrub typhus.

Tyrannidae (tyrant flycatchers; order Passeriformes) Diverse family of small to medium-sized birds which are usually grey, brown, or olive-green in colour, some being more brightly coloured. The bill is usually fairly broad with a hooked tip and rictal bristles, the wings are short and rounded to long and pointed, and the tail is usually medium-length and square, but can be greatly elongated. Tyrant flycatchers inhabit forests and open country, and feed on insects and fruit, some eating mice, frogs, and small birds. They nest in trees or on the ground. Some nests are open, others domed or pendent, and some are in tree holes or holes in the ground. There are about 115 genera, with about 380 species, many migratory, found in N., C., and S. America.

Tyrannosaurus rex Giant, carnivorous dinosaur which lived during the Upper Cretaceous in N. America and possibly in Asia. Individuals grew to 12 m in length, 5 m tall, and weighed about 7 t. The apt name means 'king of the tyrant lizards'.

Tyrannus (kingbirds; family Tyrannidae) Genus of medium-sized flycatchers, which have grey or olive upper-parts and white or yellow under-parts, with a hidden red crown stripe. They have long, pointed wings, and square or slightly forked tails, with white tips or outer feathers. They inhabit forests and open country, feed on insects, and nest in trees. There are 12 species, many migratory, found in N., C., and S. America.

tyrant flycatchers *See Elaenia*; and Tyrannidae.

tyrosine An aromatic, polar, alpha-amino acid.

Tyto (barn owls; family Tytonidae) Genus of sooty-brown, brown, and white owls which have distinctive facial discs. They are nocturnal, occasionally feeding in the daytime. They inhabit forests and open grassland; feed on small mammals, reptiles, and birds; and nest in tree holes and buildings. There are 10 species, found in Europe, Africa, S. Asia, Indonesia, New Guinea, Australia, and N., C., and S. America. *T. alba* (barn owl) is found over most of this range.

Tyto alba (barn owl) *See Tyto*.

Tytonidae (barn owls, bay owls; order Strigiformes) Family of owls, with heart-shaped facial discs which meet above the bill in *Tyto* species (barn owls) but not in *Phodilus* species (bay owls). They have feathered legs, and a pectinate middle toe. They inhabit forests and grassland; feed on mammals, birds, lizards, frogs, and insects; and nest mainly in tree cavities. There are two genera, with 12 species, found in Europe, Africa, S. Asia, Indonesia, New Guinea, Australia, and N., C., and S. America.

U

^{235}U, ^{238}U *See* radiometric dating.

ubac Applied to north-facing slopes of Alpine valleys which have reduced insolation owing to their unfavourable aspect. Land use is markedly different from that of the sunnier south-facing slopes, and often emphasizes forestry. *See also* adret.

ubiquinone Coenzyme Q; generic term for a group of compounds structurally related to vitamin K that function as electron carriers in the electron-transport chain of mitochondria.

ullucu *See Ullucus tuberosus*.

Ullucus tuberosus (ullucu; family Basellaceae) Herb with twining stems, endemic to the high Andes, and frost-resistant, which is cultivated for its edible leaves.

Ulmaceae Family of trees with simple, alternate leaves, often asymmetrical at the base, and with small, usually hermaphrodite flowers in dense clusters on the twigs. The flowers have a 4–8 lobed perianth with imbricate lobes, 4–8 stamens opposite the perianth lobes, and an ovary of two fused carpels. They are wind-pollinated. The tiny, dry or fleshy fruits are often winged. Modern classifications recognize some 13 genera, with 150 species, mostly in the northern temperate zone.

Ulmus (elms; family Ulmaceae) Genus of mostly large trees, in which the leaves are asymmetrical at the base, and usually hairy, at least beneath. The hermaphrodite flowers appear in clusters before the leaves; and the tiny nutlets have a broad, oval wing that aids wind-dispersal, and is notched at the tip. The virulent strain of Dutch elm disease that was introduced about 1968 from N. America into Europe has destroyed (or is in the process of destroying) most European elm trees, but the roots are not normally killed and many elms are re-establishing themselves from sucker shoots. The disease is caused by a fungus (*Ceratocystis ulmi*) and apparently always transmitted by the elm-bark beetle (*Scolytus*). Some E. Asiatic elms appear to be immune to this disease. Elm wood is used sometimes for making coffins, and hollowed-out elm stems were formerly used for water pipes, as the wood does not decay readily when waterlogged. There are some 30 species, occurring in the northern temperate zone, and in the mountains of the Asian tropics.

ulna In tetrapods, the postaxial bone of the fore limb.

Ulothrix (family Ulotrichaceae, order Ulotrichales) Genus of unbranched, filamentous, green algae, each cell of which contains a single chloroplast which forms an incomplete band around the middle of the cell. The filaments are attached at their bases to rocks, etc., in still or running fresh water.

Ulotrichales (class Chlorophyceae) Order of green algae in which the thallus is either filamentous, or flat and sheet-like; each cell contains a single nucleus. There are several families, found in freshwater and marine aquatic habitats, and also in terrestrial environments.

Ultisols Mineral soils, an order of the USDA Soil Taxonomy, identified by an argillic B horizon with a base saturation of less than 35%, and red in colour from iron oxide concentration. Ultisols are leached, acid soils, associated with humid subtropical environments. *See also* red podzolic soils.

ultrabasic rock Igneous rock consisting almost entirely of ferromagnesian minerals and possessing no free quartz, and with less than 45% silica (SiO_2). 'Ultramafic' is a partial synonym, since it also includes anorthositic rocks.

ultracentrifugation Centrifugation carried out at high rotor speeds (up to 75 000 rpm) and therefore under high centrifugal forces (up to 750 000 g). Analytical ultracentrifuges are employed to determine the mass and to some extent the shape of molecules; preparative ultracentrifuges are used to separate the components of mixtures on the bases of these parameters.

ultramafic *See* ultrabasic.

Ulva (family Ulvaceae, order Ulotrichales) Genus of green seaweeds in which the thallus is flat and sheet-like, and is two cells thick. *U. lactuca* (sea lettuce, green laver) is a common British species; the holdfast is perennial, producing new fronds each year. It is found attached to rocks in the intertidal zone, and in brackish water in estuaries.

umbel Inflorescence in which all the pedicels arise at the apex of an axis. It is commonly compound, usually umbrella-shaped, and is characteristic of Umbelliferae.

Umbelliferae Family of dicotyledonous herbs, with a few shrubs, in which the alternate leaves are usually much divided, and have sheathing stalks at the base. The flowers are characteristically borne in umbels, which are usually compound, and have a tiny calyx of five teeth, or no calyx. There are five free petals, which are often notched and sometimes very unequal in size; five stamens alternating with the petals; and an inferior ovary of two fused carpels, which ripens into two separating, but indehiscent parts, which may remain suspended from the tip of the axis. The carpels each bear five (or sometimes nine) ridges, usually with four oil-canals (vittae) between the main ridges and two more on the inner faces. This large family contains many important food plants, e.g. *Daucus* (carrot), *Pastinaca* (parsnip), *Apium* (celery); while others are very poisonous, e.g. *Oenanthe* (water dropwort),

or are useful medicinally. There are some 200 genera, with 2700 species, found throughout most of the world, but mainly in northern temperate regions.

Umbilicaria (family Umbilicariaceae) Genus of lichens in which the foliose thallus is roughly circular in outline, either entire or lobed, and is attached to the substrate at a point in the centre of its lower surface. The apothecia are black. It is found on non-calcareous rocks, chiefly in hilly and mountainous districts.

Umbilicariaceae (order Lecanorales) Family of lichens in which the thallus is foliose and attached to the substrate at a central point on its lower surface. The thallus has a cortex on both surfaces, and is typically whitish-grey to blackish in colour. The lower surface is naked or bears rhizines which do not function in attachment. Apothecia are usually lecideine, and may be smooth or furrowed. Spores are aseptate, or have two to many septa, and are colourless to brown. There are two genera, found almost entirely on non-calcareous rocks.

umbilicate 1 Of a fungal pileus, for example, having a central pit or depression. 2 Of a lichen, having a more or less circular thallus that is attached to a substrate by a central point on its lower surface, as in *Umbilicaria*.

umbo Convex protuberance or swelling in the centre, as in the pileus of certain fungal fruit bodies.

umbonate Having or resembling an umbo.

Umbra limi (mud minnow) *See* Umbridae.

umbric epipedon Surface soil horizon similar to a mollic epipedon but with a base saturation of less than 50%. It is a diagnostic horizon in the USDA Soil Taxonomy.

Umbridae (mud minnow; class Osteichthyes, subclass Actinopterygii, order Salmoniformes) Small family of freshwater fish which have relatively short, stout bodies. The soft-rayed, single, dorsal and anal fins are placed well back on the body, near the somewhat rounded tail-fin. The small pelvics are found just anterior to the anal fin. Capable of surviving harsh conditions (e.g. low oxygen concentration and low water temperature), *Umbra limi* (mud minnow), 15 cm, and its few relatives have an interesting distribution: USA, Alaska, Siberia, E. Europe. There are about five species.

unavailable water Water that is present in the soil but that cannot be absorbed rapidly enough by plants for their needs because it is held so strongly to the surface of soil particles.

Uncaria (family Rubiaceae) Genus of woody climbers which have woody, recurved hooks. Several are medicinal—e.g. *U. gambir* provides gambier, used for both medicine and tanning. There are 60 species, with a pantropical distribution.

uncinate process In birds, a protrusion of bone from a rib, enabling it to join on to the rib behind by means of ligaments. It is an avian feature that serves to strengthen the rib-cage, and it is absent only in the Anhimidae (screamers).

uncinus From the Latin *uncinus* meaning 'hooked', a species of cirrus cloud that is hooked at the end of its filaments and on the upper parts. *See also* cloud classification.

unconformity Surface of contact between two groups of unconformable strata which represents a hiatus in the geological record due to a combination of erosion and a cessation of sedimentation. *See also* disconformity.

unconsolidated Applied to particles that are loose and not cemented together.

underdispersion (regular distribution) In plant ecology, the situation in which the pattern of individuals of a given plant species within a community is not random, but regular, with similar numbers recorded in all quadrats. *See* pattern analysis.

underdominance *See* balanced polymorphism.

underfit stream *See* misfit stream.

understorey species The trees of the lower canopy levels in a woodland ecosystem, as distinct from emergent, crown, or upper-storey species. Some species (e.g. hazel and banana) are characteristic of the understorey, but others may be younger specimens of emergent species.

undertow General seaward flow of water beneath individual breaking waves, in contrast to the more localized rip-current return flow.

underwing moths *See* Noctuidae.

underwood 1 Wood, either growing or cut, that consists of coppice or pollard regrowth, or small shrubs and saplings grown from seed or suckers. 2 The lower storey of a forest crop.

undulant fever Brucellosis in humans.

undulatus From the Latin *undulatus* meaning 'waved', a variety of cloud whose layers undulate. *See also* cloud classification.

unequal crossing-over In genetics, a cross-over after improper pairing between chromosome homologues that are not perfectly aligned. The result is one cross-over chromatid with one copy of the segment and another with three copies. The phenomenon was first described at the *Bar* locus in *Drosophila*.

ungulate 1 Any hoofed, grazing mammal, which usually is also adapted for running. Hoofed mammals occur in several mammalian groups, and the term 'ungulate' no longer has any formal taxonomic use. 2 Hoof-shaped.

unguligrade Applied to a gait in which only the tips of the digits, covered with hoofs, touch the ground.

unicentric distribution Such endemics as occur in Scandinavia are concentrated into the same one or two areas. About 40 are found in just one of the two areas, and these are described as having a unicentric distribution. The two areas concerned are thought

by some authorities to have been refuges from the glaciation of the late Pleistocene, i.e. they were nunataks above the ice sheets.

unicorn plant *See* Martyniaceae.

unicuspid Applied to a tooth that has only one cusp or biting point.

uniformitarianism The principle proposed by James Hutton (1726–97) and paraphrased succinctly as 'the present is the key to the past'. This is a considerable oversimplification, since processes that occurred in historical times may not be occurring now or may not be observable now, and vice versa.

unilocular 1 In plants, with one locule. 2 *See* Symphyta.

Unionoida (phylum Mollusca, class Pelecypoda) Order of unequilateral, and generally equivalved, marine and non-marine pelecypods whose shell shape and size is very variable, and whose ornamentation is usually simple. The musculature is isomyarian to subisomyarian. The ligament is external and opisthodetic. The dentition is quite variable, forms having one or two teeth, some pseudotaxodont and some edentulous. They first appeared in the Upper Devonian.

uniramous Unbranched.

uniseriate Arranged in a single row.

unisexual flower Flower possessing only stamens or carpels but not both. A plant may be unisexual (dioecious), possessing only male flowers or female flowers; or it may be monoecious with male and female reproductive organs borne in the same flower or in different unisexual flowers but on the same plant.

unitunicate Applied to an ascus in which layers of the ascus wall do not separate during ascospore release.

univalent A single chromosome observed during meiosis when bivalents are also present. A univalent has no pairing (synaptic) mate. An example is the sex chromosome of an XO male.

universal veil Membranaceous structure which encloses the young fruit body in certain types of agaric; the universal veil is ruptured as the fruit body expands.

univoltine Applied to species in which one generation reaches maturity each year.

unques *See* empodium.

unsaturated flow Movement of water through soil that is not saturated, from regions of higher to regions of lower pressure.

upas tree (ipoh) *See Antiaris*.

Uppsala school of phytosociology A set of floristic methods intended mainly for the classification of vegetation communities, developed by G. E. du Rietz and others in Uppsala, Sweden, starting in 1921, at first quite independently of the work of the Zurich–Montpellier (Z–M) team. More recently the approaches have converged as many ideas have been modified in the light of Z–M work in an attempt to link the two. The main distinction between them lies in the emphasis placed by the Uppsala scheme on exclusive or preferential species of high constancy or dominance, rather than fidelity, to define the basic community types. *Compare* Zurich–Montpellier school of phytosociology.

upside-down catfish *See* Mochokidae.

upslope fog Condensation near the surface in uplifted air on windward slopes.

Upupa epops (hoopoe) *See* Upupidae.

Upupidae (hoopoe; order Coraciiformes) Monotypic family which comprises *Upupa epops*, a pinkish, chestnut bird with black and white banded back, wings, and tail. It has a long, distinctive, black-tipped crest; a long, slender, decurved bill; broad, rounded wings; and a medium-length, square tail. Its legs are short with long toes, the third and fourth being fused basally. It inhabits fairly open country and cultivated land, feeds mainly on insects, and nests in holes in trees and banks. It is migratory, and is found in Europe, Africa, and Asia.

upwelling In oceans or larger lakes, a water current, or movement of surface water produced by wind, which brings colder water, loaded with nutrient, to the surface from a lower depth. Ocean upwellings occur off Peru, California, and Namibia, and increase the nutrient content of the surface waters, leading to an abundance of marine and bird life.

uracil A pyrimidine base that occurs in RNA.

Uraniidae (order Lepidoptera) Small family of small to large moths related to the Geometridae. The hindwings are extended into 'tails' and resemble those of papilionid butterflies. Many species are diurnal; the nocturnal members are whitish. The larvae pupate in loosely woven cocoons. The family is predominantly tropical and occurs in both Old and New Worlds.

uraninite (pitchblende) Mineral, specific gravity varying from 8.5 when massive to 10 for unaltered crystals, hardness 5.0–6.0, chemical composition UO_2. It occurs in pegmatites, and in association with monazite, zircon, and tourmaline, and in hydrothermal veins together with cassiterite, pyrite, chalcopyrite, and galena. It is also found as a detrital material in alluvials. It is distinguished by its high specific gravity, its greasy, pitch-like lustre, its colour, and its radioactivity. It is brownish-black or grey-black, and has a brownish-black streak, and a sub-metallic, greasy lustre. It crystallizes in the cubic system. Crystals are very rare, and the mineral is usually found as botryoidal masses. It is a major ore for uranium metal.

uranium isotope dating *See* radiometric dating.

Uranoscopidae (stargazer; class Osteichthyes, subclass Actinopterygii, order Perciformes) Family of marine, bottom-living fish which have a solid, stout body, the eyes located on the top of the large head, and a large mouth in an almost vertical position. A distinct notch separates the two parts of

the dorsal fin, with the anal fin being larger than the second dorsal. Some species, e.g. *Uranoscopus scaber* (35 cm) of the E. Atlantic, possess a well-developed and poisonous spine located behind the gill cover. They often lie partially buried in the sand with only the mouth and eyes visible, wriggling a small, worm-like tentacle on the lower jaw in order to attract prey fish. There are about 25 species, distributed worldwide.

Uratelornis chimaera (long-tailed groundroller) *See* Brachypteraciidae.

urban climate Modified surface-layer atmospheric conditions caused by the influence of large 'built-up' areas. Changes include pollution, reduction in strong wind speeds toward a city centre, turbulence of air around buildings, warming of air by the heat output from city structures, and increased evaporation and removal (drainage and run-off) of water.

urceolate Flask-shaped.

urea $CO(NH_2)_2$; the compound formed from carbon dioxide and ammonia via the urea cycle as a result of amino-acid catabolism in ureotelic animals. It is also the final product of purine catabolism in most fish, amphibia, and freshwater bivalve molluscs.

urea cycle Cyclic series of reactions by which carbon dioxide and ammonia, the latter derived from amino groups from amino-acid catabolism, are converted to urea prior to excretion.

urease The hydrolytic enzyme that catalyses the reaction whereby urea is converted into carbon dioxide and ammonia.

Uredinales (rust fungi; class Teliomycetes) Order of fungi which are obligate parasites of a wide variety of plants including angiosperms, gymnosperms, and pteridophytes. Many have complex life cycles that involve the sequential formation of up to five different types of spore. Some rusts can complete their life cycle in a single host plant, while others require two different host species.

urediniospore *See* uredospore.

uredinium *See* uredium.

urediospore *See* uredospore.

uredium (uredinium, uredosorus) Region of fungal tissue within which spores (called uredospores) develop in a plant infected with certain rust fungi (order Uredinales).

uredosorus *See* uredium.

uredospore (urediospore, urediniospore) Type of fungal spore which is borne on a thin stalk (pedicel) in a structure known as a uredium.

ureotelic Applied to organisms that excrete in the form of urea nitrogenous waste derived from amino-acid catabolism, e.g. elasmobranchs, adult amphibia, and mammals.

ureter Urinary duct draining from the kidney to the bladder.

urethritis Inflammation of the urethra. Urethritis may be caused by any of a variety of bacteria, or it may be due to non-microbial causes.

uric acid Nitrogen compound ($C_5H_4N_4O_3$) that forms the principal end-product of amino-acid catabolism in insects, birds, and reptiles. It is also present in the urine of other organisms where it represents the final product of purine catabolism.

uricotelic Applied to organisms that excrete in the form of uric acid nitrogenous waste derived from amino-acid catabolism, e.g. insects, birds, and terrestrial reptiles.

uridine The nucleotide formed when uracil is linked to ribose sugar.

uridylic acid The nucleotide formed from uracil.

Urocerus gigas (formerly *Sirex gigas*, common horntail; superfamily Siricoidea, family Siricidae) Species of symphytans in which the adult resembles a hornet, but lacks the constricted wasp waist. The head and thorax are black and the abdomen yellow (with a broad, transverse, black band in females). The large ovipositor is used for boring deep into pine and other coniferous trees. The larvae may take up to three years to reach maturity. *U. gigas* is the commonest British species in their family and are harmless, although they are frequently mistaken for a stinging insect and killed.

Urochordata Phylum comprising the sea squirts, with reliable fossils from the Permian, and possible remains in Silurian sediments. They have tadpole-like larvae with notochords in their tails, a feature that links them with the chordates.

Urodela (Caudata; newts, salamanders; class Amphibia) Modern order of tailed amphibians, of which there is a late Jurassic representative in the fossil record. This order, and the other two living amphibian orders (collectively grouped into the subclass Lissamphibia), seem on the basis of their vertebral characteristics to be descended from the Palaeozoic Lepospondyli, but the teeth and other characteristics of the Lissamphibia are unlike those of any Palaeozoic amphibians. Most are four-legged and lizard-shaped, but some are elongate and eel-like, with the limbs degenerate. The tail is never lost at metamorphosis. Fertilization is internal, spermatophores being transferred during an elaborate courtship ritual. Sexual dimorphism is common, with breeding colours and median-fin enlargement in the males of some species. The usual length is 7–30 cm, but the giant salamanders (Cryptobranchidae) may reach 150 cm. Distribution is largely in the northern temperate zone, but some genera span the equator into S. America. There are about 450 species in eight families: Hynobiidae, Cryptobranchidae, Ambystomatidae, Salamandridae, Amphiumidae, Proteidae, Plethodontidae, and Sirenidae.

urogoga *See Hybanthus*.

Uromastyx (spiny-tailed lizards; order Squamata, suborder Sauria (Lacertilia), family Agamidae) Genus of large (up to 90 cm long), sturdy agamids in which the tail is short and thick, bearing spiny rings of scales, and is lashed violently in defence. Adults are herbivorous. They occur in desert regions of N. Africa and Asia Minor.

uropatagium In Chiroptera, the part of the patagium which extends between the hind limbs.

Uropeltidae (shield-tailed snakes; order Squamata, suborder Serpentes (Ophidia)) Family of primitive burrowing snakes, which resemble the blind snakes (Typhlopidae), but possess an enlarged, modified scale near the tip of the tail (possibly an aid to burrowing or to anchor them in the ground). Reproduction is viviparous. There are about 45 species, occurring in India and Sri Lanka.

uropod In Malacostraca, a ramus of the sixth abdominal appendage, comprising a large, flattened, paddle-like structure which, with the telson, forms a tail-fin used in swimming.

Uropygi (schizomids, whipscorpions; class Arachnida) Order of small to medium-sized (up to 7.5 cm long) arachnids in which the prosoma is not divided dorsally, and the large pedipalpi are held flexed and parallel to the ground. The last abdominal segment bears a many-segmented flagellum. Whipscorpions possess anal spray glands used in defence, the secretions being largely acetic acid with some caprylic acid to aid cuticle penetration. Usually brownish and flat, whipscorpions live under stones, stump bark, and rubbish, and prey on small arthropods (e.g. crickets) and small toads. Schizomids are smaller, up to 7 mm long, and possess a very short, terminal, abdominal flagellum. The pedipalpi are leg-like and raptorial, not chelate. The two small chelicerae are tipped by small pincers. As in the whipscorpions, there are anal glands, and schizomids live under stones and leaf litter. Uropygids possess sensory trichobothria, slit organs, and pits, inhabit the tropics and subtropics, and have reproduction similar to that of scorpions. There are 75 known species of whipscorpion and more than 50 known species of schizomid.

Ursidae (bears; order Carnivora, suborder Fissipedia, superfamily Canoidea) Family of large, slow-moving mammals whose ancestors were the last group of canoids to diverge from the ancestral 'dog' line, some time during the Miocene and probably soon after that line became established. They are distinctive within the order Carnivora, for the departure involved an adaptation to an omnivorous and mainly herbivorous diet. The last molar is absent, the remaining molars being elongated and having grinding surfaces, and the carnassials are weakly developed. The gait is plantigrade, the claws non-retractile. Bears are distributed throughout much of the northern hemisphere apart from Africa, and in S. America. There are seven species, in five genera (six if the giant panda (*Ailuropoda*) is also included).

Urtica (nettle; family Urticaceae) Genus of annual or perennial herbs with ridged stems, opposite, simple leaves, and numerous stinging hairs. The flowers are small, green, and unisexual, in clusters along spike-like stems in leaf axils, and both sexes of flowers may occur on the same plant, or the plants may be dioecious. There are some 30 species, mostly found in temperate regions.

Urticaceae Family of small trees, shrubs, or dicotyledonous herbs, often with stinging hairs, with simple leaves, and only small, usually unisexual, clustered flowers. The flowers have a perianth of four or five segments, four or five stamens in the male flowers, and a one-celled ovary in the female. The fruits are either dry nutlets or drupes. Modern classifications recognize about 40 genera and 500 species, distributed widely in most regions of the world.

USDA United States Department of Agriculture.

Usnea ('beard lichens'; family Usneaceae) Genus of fruticose lichens, commonly known as 'beard lichens' owing to their tufted, filamentous appearance and frequently pendulous habit. The numerous species are often variable and are notoriously difficult to distinguish from one another. *Usnea* species are very sensitive to atmospheric pollution and are found only in unpolluted areas on trees or rocks.

Usneaceae (order Lecanorales) Family of lichens in which the thallus is fruticose and radially symmetrical in cross-section; it may be erect or pendulous. The apothecia are lecanorine. Typically spores are colourless and aseptate. There are several genera, and numerous species, found on various types of substrate, mainly in humid regions.

usnic acid A substance which has some antibiotic activity, found in certain species of lichens. Usnic acid is active against some Gram-positive bacteria and has been used in ointments for the treatment of local skin infections.

Ustilaginales (smut fungi; class Teliomycetes) Order of fungi which are parasitic on angiosperms, often causing diseases of economic importance, especially in cereals. The fungus forms masses of dark, powdery spores in the leaves, stems, flowers, or fruits of the host plant.

Ustilago (family Ustilaginaceae, order Ustilaginales) Genus of smut fungi in which teliospore germination gives rise to a transversely septate promycelium which bears lateral basidiospores. The teliospores are single-celled. Species are parasitic on a range of plants, causing some important diseases, e.g. *U. nuda* is responsible for loose smut of barley, and *U.avenae* causes loose smut of oats.

utile *See Entandophragma*.

Utricularia (bladderwort) *See* Lentibulariaceae.

V

vaccinia virus Virus, belonging to the poxviruses, which is used in the preparation of smallpox vaccine.

Vaccinium (bilberry; family Ericaceae) Genus of mostly low shrubs, often evergreen, with alternate, simple leaves, tetra- or pentamerous flowers with mostly bell- or urn-shaped corollas and inferior ovaries, and berry-like fruits. There are some 130 species, found mostly in the northern temperate zone and the arctic, with some tropical mountain outliers. Several species are cultivated, particularly the American cranberry (*V. macrocarpon*), with reflexed corolla lobes, from whose berries cranberry sauce is made; European cranberry (*V. oxycoccos*) is a similar but smaller species, also with edible berries, found in bogs throughout the northern temperate zone.

Vaccinium macrocarpon (American cranberry) *See* *Vaccinium*.

vacuity (zool.) Gap between bones of the skull.

vacuole Membrane-bound sac found in many cells, normally acting as a storage organ of various types. A large central vacuole is a particular feature of many plant cells, where it can occupy 80–90% of the total cell volume.

vacuum activity Patterns of behaviour that occur in the absence of the external stimuli that normally elicit them.

vadose zone (zone of aeration) The unsaturated zone in a soil where chemical processes are at their most active. Its extent is determined partly by the content of the soil water, but it cannot extend beyond the water table, below which voids are completely filled with water. *See also* phreatic zone.

vagabond butterfly fish (*Chaetodon vagabundus*) *See* Chaetodontidae.

vagile Applied to a plant or animal that is free to move about. *Compare* sessile.

vagility The tolerance of an organism to a wide range of environmental conditions; vagility may be qualified as 'high' or 'low'.

valency Measure of the number of other ions of a chemical element that can be combined with a particular atom.

valerian (*Valeriana*) *See* Valerianaceae.

Valeriana (valerian) *See* Valerianaceae.

Valerianaceae Family of dicotyledonous herbs with opposite or wholly radical leaves, which are often pinnatifid and have no stipules. The inflorescence is a cymose, often dense or sometimes umbellate head of small flowers, which may be irregular. The calyx either is merely a ring, or forms a feathery pappus in fruit. The corolla is funnel-shaped, and sometimes spurred below. There are 1–4 stamens, attached to the usually five-lobed corolla. The ovary is inferior, three-celled, but with only one cell fertile. The fruit is dry and indehiscent. Modern classifications recognize about eight genera, with 350 species, distributed widely except in Australia. *Valerianella* (corn salad) has been used as a vegetable. *Centranthus* (spurred valerian) is grown in gardens. *Valeriana* (valerian) has medicinal uses.

Valerianella (corn salad) *See* Valerianaceae.

valine An aliphatic, non-polar, alpha-amino acid.

valinomycine Ionophorous antibiotic produced by *Streptomyces fulvissimus*, consisting of a ring of alternating hydroxy and amino acids. It affects membrane potentials by increasing their permeability to potassium ions and as a consequence of this acts as a powerful uncoupler of mitochondrial oxidative phosphorylation.

valley bog Bog community developing in wet valley bottoms, valleys with some downstream impedence, or badly drained hollows, where the ground water is base-poor and acidic conditions result. *See also* bog; *compare* blanket bog; fen; ombrogenous peat; and raised bog.

valley train Accumulation of alluvium laid down in a valley by meltwaters escaping from a decaying glacier. The surface slopes quite steeply down-valley, and is incised by shifting braided streams.

valley wind Anabatic wind that blows up-valley during the day in otherwise calm conditions. The katabatic, down-valley, night wind is also a valley wind. *See also* mountain wind; and ravine wind.

value *See* Munsell colour.

valvate Applied to the arrangement (aestivation) of sepals or petals in a flower bud such that these parts meet at their edges and do not overlap. Where they overlap, the aestivation is described as 'imbricate'.

valve **1** One of the portions into which a fruit splits. **2** One of the two halves of the hinged shell of molluscs of the class Bivalvia. **3** One half of the cell wall of a diatom. **4** A flap that can close to ensure that a fluid flows in only one direction, e.g. in a blood vessel or heart. **5** *See* ovipositor.

vampire bat *See* Desmodontidae.

Vampyromorpha (class Cephalopoda, subclass Coleoidea) Order of cephalopods which have eight arms and two retractable arms. An uncalcified, internal shell is also present. The order contains a single family, the Vampyroteuthidae.

Vampyroteuthidae *See* Vampyromorpha.

vanadinite Relatively rare mineral, specific gravity 6.7–7.1, hardness 3, and with the chemical composition $Pb_5(VO_4)_2Cl$. It is found in the oxidized zone of sulphide-ore deposits carrying lead

minerals. It is distinguished by its hexagonal form, lustre, high specific gravity, and colour. It is orange-red, brownish-red, to yellow, and has a white to yellowish streak, and a resinous lustre. It crystallizes in the hexagonal system. The crystals are sharp, hexagonal prisms, but occasionally rounded. Vanadinite can be used as a source of vanadium.

vane Device for indicating the direction of wind. The standard exposure for wind vanes is on a mast at 10 m above unobstructed ground.

Vanellus (plovers, lapwings; family Charadriidae) Genus of medium-sized waders, most of which have striking black and white wing patterns, and white tails with a black terminal band. Many have crests, facial wattles, and carpal spurs. They have rounded wings, and medium to long legs. They inhabit open ground near water, feed on invertebrates, and nest on the ground. There are 24 species, many migratory, found in Europe, Africa, Asia, Australia, and S. America.

Vanessa atlanta (red admiral butterfly; order Lepidoptera, family Nymphalidae) Species of migratory butterfly in which the upper surfaces of the wings are black with scarlet bands, white blotches, and blue marks. Larvae feed on Urticaceae, particularly nettles. The butterfly overwinters as an adult. It is widespread in the northern hemisphere. There are different subspecies in the Old and New Worlds.

vanessas *See* Nymphalidae.

vangas *See* Vangidae.

Vangidae (vangas; order Passeriformes) Family of small to medium-sized birds which have contrasting black, blue, white, brown, or grey, patterned plumage. Their bills are stout and hooked, and vary from slim and decurved to deep and enlarged. They have short to long, rounded wings, and fairly long tails. They are arboreal, inhabit forests and brush, feed on insects and other animals, and nest in trees. There are eight genera, with 12 species, confined to Madagascar.

van Valen's 'law' When plotted as cumulative curves on a logarithmic scale, the duration frequencies of many species tend to show a more or less straight-line relationship with time. In effect, taxa generally become extinct regardless of their age. Duration frequencies vary greatly among different groups, e.g. on average bivalve genera last 10 times longer than mammalian genera. The 'law' is named after its discoverer, L. van Valen.

vapour pressure The partial pressure exerted by vapour molecules in equilibrium with liquid in a closed vessel at a given temperature and external pressure. This is a characteristic property of the liquid.

Varanidae (monitors; order Squamata, suborder Sauria (Lacertilia)) Family of large, agile, predatory lizards which typically have a pointed head, a large tympanum, a long, slender neck, a massive body, powerful clawed limbs, and a long thick tail. The scales are small and granular. Most monitors are good climbers and swimmers. There are about 30 species, occurring in tropical and subtropical regions of the Old World and Australia. *See also* ***Varanus komodoensis***.

Varanus komodoensis (Komodo dragon; order Squamata, suborder Sauria (Lacertilia), family Varanidae) The largest living lizard, males being larger than females, up to 3 m long and 140 kg in weight. Adults eat mainly deer, pigs, and monkeys (often as carrion). The young feed on insects and small vertebrates. The Komodo dragon is a native of the Indonesian islands Komodo, Rintja, Flores, and Padar.

vardar (vardarac) Type of ravine wind, which blows in the Moravia-Vardar valley, bringing cold conditions from the north to the Thessaloniki area of Greece.

variance *See* mean square.

variation Differences displayed by individuals within a species, and which may be favoured or eliminated by natural selection. In sexual reproduction, reshuffling of genes in each generation ensures the maintenance of variation. The ultimate source of the variation is mutation, which produces fresh genetic material.

varicella *See* chickenpox.

variegation (in plants) The phenomenon in some plants in which patches of two or more different colours occur on the leaves or flowers; variegation may be an inherited characteristic or may be due to virus infection.

variola 'Variola major' is another name for smallpox. 'Variola minor' refers to the similar but milder disease also known as 'alastrium'. Other diseases caused by poxviruses may also be termed 'variola', e.g. 'variola ovina', which is sheep pox.

varve A banded layer of silt and sand deposited annually in lakes, especially near to ice sheets. The coarse, paler material is deposited in summer; the finer, darker material in winter. One varve consists of one light band and one dark band. Varves can be used to determine the length of time of deposition; and since each pattern is often distinctive, comparisons can be made between deposits.

vascular bundle In a plant, discrete, longitudinal strands that consist principally of vascular tissue (xylem and phloem). These form a continuous conductive system throughout the plant along which water and soluble nutrients pass. This vascular system also contributes to the structural support of the plant.

vascular plants *See* Tracheophyta.

vascular system *See* vascular bundle; and vascular tissue.

vascular tissue In a plant, tissue through which water and nutrients move. *See also* vascular bundle; phloem; and xylem.

vasopressin (antidiuretic hormone, ADH) Peptide hormone secreted by the neurohypophysis in mammals that increases blood pressure and regulates the rate of water loss by the kidneys.

Vatica (family Dipterocarpaceae) Genus of medium to small, evergreen trees which yield a siliceous timber (resak). There are 76 species, occurring in S. India, Sri Lanka, and from Hainan to New Guinea.

Vaucheria (order Vaucheriales, class Xanthophyceae) Genus of algae which have little in common with the other members of the Xanthophyceae apart from the presence of forward-directed tinsel and backward-directed whiplash flagella on the spermatozoids. The algae are bright green, filamentous, coenocytic, and irregularly branched. They are common in still or slow-moving fresh water and on damp soil.

Vavaea (family Meliaceae) Genus of trees or treelets which have simple leaves held in terminal clusters, and tiered branches. The fruit is a berry, with the pericarp rather woody. There are four species, occurring from Sumatra to Polynesia.

vector Organism that carries a disease-causing organism from an infected individual to a healthy one; the vector may transfer the pathogen passively or may itself be infected by the pathogen.

veering Clockwise shift of the direction of the wind. The reverse change is called backing.

vegetable ivory The bony endosperm of certain palms, mainly *Phytelephas* (New World) and *Metroxylon* (eastern tropics). *See also Corypha*.

vegetation A collection of plants of diverse, or the same species. It is classified in many different ways, according to origin, appearance, and functional characteristics. Geographically, much emphasis is given to climax vegetation, which reflects the influence of climate, soils, and humans.

vegetation mosaic The pattern of different plant communities, or stages of the same community. The term is applied particularly to communities that show cyclical change, e.g. heathlands (*Calluna* cycle) or raised bogs (hummock-and-hollow cycle), with examples of all stages being present together in a typically extensive and well-developed community.

vegetative Applied to a stage or structure that is concerned with feeding and growth rather than with sexual reproduction. Vegetative reproduction is asexual reproduction.

vegetative cell An actively growing cell, as opposed to a cell that forms spores (spore mother cell).

vegetative nucleus 1 The tube-nucleus of a pollen grain in a flowering plant. 2 The macronucleus of a ciliate animal.

vegetative propagation (vegetative reproduction) Reproductive process that is asexual and so does not involve a recombination of genetic material. It involves unspecialized plant parts which may become reproductive structures, e.g. roots, stems, or leaves. Compared with sexual reproduction, it represents a saving of material and energy for the plant. It is especially common among grasses.

vegetative reproduction *See* vegetative propagation.

vegetative state 1 Stage in the life cycle of a plant when reproduction proceeds asexually by detachment of some part of the plant body and its subsequent development into a complete plant. 2 The non-infective state in a phage during which the genome multiplies actively and controls the synthesis by the host (a bacterial cell) of the materials necessary for the production of infective particles (i.e. more phages and phage DNA). These are released by lysis of the host cell.

Veillonellaceae Family of Gram-negative bacteria which grow only in the absence of air. Cells are spherical and characteristically occur in pairs. They are non-motile, and chemo-organotrophic. They are found as parasites in animals including humans, occurring chiefly in the intestine.

vein 1 Blood vessel through which blood is conveyed towards the heart. 2 Tabular deposit of minerals occupying a fracture, in which particles grew away from the walls toward the middle. 3 (bot.) A vascular bundle within a leaf.

vein-banding Symptom of some virus diseases of plants in which bands of lighter or darker colour occur along the main veins of a leaf.

vein-clearing Symptom of some virus diseases of plants in which the veins become unnaturally clear or translucent.

veld Extensive grasslands in the east of the interior of S. Africa, often with a scattering of trees or bushes. In these instances the names 'tree veld' and 'bush veld' respectively are applied. True grass veld is confined to the high terrain.

Veliferidae (veil-fish; class Osteichthyes, subclass Actinopterygii, order Lampridiformes) Small family of deep-bodied, marine fish, which have long and high, multi-rayed, dorsal and anal fins, as well as a strongly forked tail-fin. The mouth is small, but highly protractile. *Velifer multispinosus* (Pacific veil-fin), 25 cm, is one of the three species inhabiting the deeper waters of the Indian and Pacific Oceans.

Velifer multispinosus (Pacific veil-fin) *See* Veliferidae.

veliger In Mollusca, a larva developed from a trochophore, which possesses an enlarged ciliated lobe used in swimming, lost as the veliger develops, and a mantle, foot, shell, and other adult features.

Vellozia (family Velloziaceae) Genus of monocotyledonous plants which have woody, branching stems, and crowded, narrow, xeromorphic leaves with persistent bases. The flowers are regular and trimerous, and the ovary is inferior. The fruit is a woody capsule. There are 100 species, occurring mostly in seasonal tropical America, but also in Africa and Madagascar.

velum From the Latin *velum* meaning 'ship's sail'. 1 In Mollusca, the ciliated lobe possessed by the veliger larva. 2 In most hydroid medusae (Coelenterata), a ridge or narrow shelf inside the border of the subumbrellar cavity which reduces the size of the subumbrellar aperture and so increases the force of the water jet by which the medusa swims

vertically. 3 An accessory cloud feature of cumulus or cumulonimbus characterized by a widespread veil on or above the upper surface of the cloud. *See also* cloud classification.

velvet ants *See* Mutillidae.

velvetfish *See* Aploactinidae.

velvet shank *See Flammulina*.

vena cava In tetrapods, the main veins draining blood to the heart. The vena cava superior serves the fore-limbs and head, usually as a pair of veins, but in many mammals only the right member of the pair persists in adults. The vena cava inferior is a single median vein, the largest in the body, serving almost all of the body behind the fore limbs.

venation 1 The arrangement of the veins or nerves of a leaf. 2 The pattern formed by the arrangement of the veins on the wings of insects. The veins carry a tracheal trunk and a nerve, and are connected to the haemolymph. They are given a system of letters and numbers which allows their precise arrangement to be described. Venation is frequently used as a taxonomic character.

vendavale Strong, local south-westerly wind affecting the Straits of Gibraltar, associated with a depression, and bringing squalls and heavy rainfall.

venereal disease Disease that is transmitted by sexual intercourse.

Veneroida (phylum Mollusca, class Pelecypoda) Order of mainly equivalve pelecypods which have true heterodont dentition, an opisthodetic ligament, and an isomyarian musculature. Most are vagile or nestling. The shells are commonly ornamented with concentric ribbing. Veneroida first appeared in the Middle Ordovician.

Venezuela and Guiana floral region Part of Good's (1974) Neotropical kingdom, a region which has affinities with the adjacent Andean and Amazon floral region, but nevertheless constitutes an independent unit with around 100 endemic genera. The flora is poorly known and has yielded no plants of any great value.

Venice system System for the classification of brackish water based on the percentage of chlorine contained in the water. *See* brackish water.

venomous lizards *See* Helodermatidae.

vent breccia *See* breccia.

venter *See* archegonium.

ventifact (dreikanter) Pebble that has been faceted by the abrasive action of wind-blown sand and dust. Multiple faceting may reflect pebble movement as underlying sand is disturbed, rather than changes in wind direction. Each facet faces the direction of the abrading wind.

Ventilago (family Rhamnaceae) Genus of trees and shrubs of which many are climbers using hooks. They have opposite or alternate, simple leaves without stipules. The flowers are small, inconspicuous, bisexual, regular, and usually borne in cymes. There are four or five sepals and four or five incurved petals, often enclosing the stamens. The ovary is superior with two or three locules with a single ovule. The fruit has a single wing on the upper end. There are 37 species, found mainly in Asia. *V. oblongifolia* is used in Malaysia as a poultice to cure cholera, and several species may contain quinine.

ventral tube *See* Collembola.

Venturia (family Venturiaceae, class Loculoascomycetes) Genus of fungi which occur as parasites and pathogens of higher plants. The ascospores are typically greenish-yellow, elongated and septate, and are formed in pseudothecia which are immersed in the substrate. *V. inaequalis* is the cause of apple scab.

veranillo In S. America, the short period of finer weather that occurs during the summer wet season.

verano In tropical America, the drought season that occurs in winter.

Verbena *See* Verbenaceae.

Verbenaceae Family of herbs, shrubs, trees, and woody climbers, mostly with opposite leaves, and with flowers that are variously arranged, but are always irregular and hermaphrodite, with superior ovaries. The calyx and corolla are often two-lipped, and the petals are joined into a tube below. The ovary has a terminal style, and is usually four-celled. The fruit is usually a drupe, sometimes a capsule, or rarely consists of four nutlets. The family contains many useful plants, e.g. *Tectona grandis* (teak), valuable for its timber in SE Asia. Species of *Verbena* and *Clerodendrum* are grown for their attractive flowers. *Avicennia* is a mangrove of coastal swamps. Modern classifications recognize some 80 genera and 800 species. Most are tropical and subtropical, but some extend into temperate zones.

verdin *See* Remizidae.

vermiculite Mineral, with a specific gravity of 2.3, a hardness of 1.5, and the chemical composition $Mg_3(AlSi)_4O_{10}(OH)_2.4H_2O$, whose name is derived from the Latin for 'worm'. It occurs as an alteration product of biotite, from the hydrothermal alteration of biotite and phlogopite, and from the alteration of ultrabasic rocks. It is distinguished by its great expansion on heating. It is yellow or brown, and has a pearly lustre. It crystallizes in the monoclinic system. The crystals are flat and platy. It is used extensively for insulation and as a lubricant. *See also* clay minerals.

Vermivora (New World warblers; family Parulidae) Genus of green or brown warblers which have striking areas of yellow, orange, red, black, and blue on their wings, head, or throat. They inhabit forests, feed on insects, and nest on the ground or in bushes. There are 11 species, most migratory, found in N., C., and S. America.

vernal In the late spring. The term is used with reference to the six-part division of the year used by ecologists, especially in relation to studies of terrestrial or freshwater communities. *Compare* aestival; autumnal; hibernal; prevernal; and serotinal.

vernalization The treatment of germinating seeds with low temperatures to induce flowering at a particular preferred time. For example, winter varieties of wheat can be sown in the spring and then be exposed to a temperature just above 0 °C for a few weeks. The result of this is that they behave like spring varieties and flower in the same year—otherwise, they would continue to grow vegetatively and would not flower until the following year. The cold stimulus is perceived by the apical meristem (either in the embryo or as an apical bud), and some plant hormones such as gibberellin can be used to achieve the same effect.

vernation The arrangement of bud scales or young leaves in a shoot bud. They may be rolled lengthwise (circinate); pleated lengthwise (plicate); rolled from the sides to the centre of the under-side (involute); rolled from the sides to the centre of the upper side (revolute); rolled from the sides with one side folded around the other (convolute); or folded so that each leaf clasps those next to it inside the fold (conduplicate).

Vernicia *See Aleurites.*

Veronica (speedwell; family Scrophulariaceae, subfamily Rhinanthoideae) Genus of annual or perennial herbs or shrubs which have simple or lobed, opposite leaves without stipules. The flowers are most usually blue, but sometimes pink or white. They are bisexual and are held in axillary or terminal racemes, or, if they are five-lobed, solitarily in leaf axils. The calyx is fused and four-lobed, or five-lobed but with a very small upper lobe. The corolla is fused into a very short tube with four lobes; the upper, composed of two fused components, being the largest. There are two stamens and a superior ovary of two fused carpels. The fruit is an elongated, flattened capsule. There are more than 200 species, present throughout temperate regions in a wide variety of habitats. Many species are cultivated as ornamentals.

verruca *See* wart.

Verrucariaceae (order Verrucariales) Family of lichens in which the thallus is crustose or foliose, and grey to brown in colour. The ascocarps are perithecia which may be sessile or immersed in the thallus or substrate. Spores are large, thin-walled, and aseptate or septate. There are several genera, found mainly on rocks, walls, etc.

verrucose Warty in appearance.

vertebra One of the small bones or cartilages forming the backbone characteristic of vertebrates. The vertebrae are joined longitudinally and lie near the dorsal side of the body. In most animals they are hollow and form a tube, connected to the skull, enclosing the spinal cord.

Vertebrata (phylum Chordata) Subphylum which includes the fish, amphibians, reptiles, birds, and mammals, which appear successively in the fossil record, starting in the Ordovician. The lower chordates are soft-bodied and first appear in the Cambrian. The living *Amphioxus* is a lower chordate.

vertebratus A variety of cloud, usually with cirrus, with cloud elements characterized by a skeletal arrangement, in a form resembling vertebrae. *See also* cloud classification.

verticillate Arranged in a whorl or whorls.

Verticillium (class Hyphomycetes) Form-genus of fungi which produce colourless, aseptate conidia. Species are responsible for a number of important plant diseases, including a type of wilt.

verticillium wilt Plant disease caused by a fungus of the genus *Verticillium*. The infected plant may show wilting, with bending downwards and yellowing of the lower leaves. When the stem is cut well above ground level, characteristic brown streaks can be seen inside the stem following the conducting elements.

Verticordia (family Myrtaceae) Genus of small shrubs which have small, opposite leaves. The flowers are generally found in terminal clusters. They are white, red, or yellow. Both the lobed calyx and the five petals are fringed or deeply cut. The stamens are united into a tube. The fruit is a small nut with the persistent perianth remaining on the nut when it falls. The shrubs are found in areas of low fertility, e.g. heaths and scrubby woodland, and many species are xerophytes. There are 50 species, all endemic to Australia, and generally restricted to the west.

Vertisols Mineral soils, an order of the USDA Soil Taxonomy, that contain more than 30% by weight swelling clay (e.g. montmorillonite), and that expand when wet and contract when dry to produce a self-inverting soil and an undulating (gilgai) microrelief. Vertisols are associated with seasonally wet and dry environments, and are extensive in the tropics.

vesicle 1 Variably shaped cavity in a rock (generally igneous), formed as a result of entrapped gases. Such cavities may later become filled with material deposited from solution. *See also* amygdale. 2 Generally, any small bladder-like structure containing a fluid. 3 Small, membrane-bound, fluid-filled sphere that occurs, often in large numbers, in the cytoplasm of many eukaryotic cells. Vesicles may be variously associated with the uptake and discharge of materials in cells and also with their transport and storage.

vesicular basalt Basaltic lava containing numerous openings, generally ellipsoidal or cylindrical in shape, formed by the expansion of dissolved gases in the molten rock.

Vesicularina (class Gymnolaemata, order Ctenostomata) Suborder of bryozoans in which the stolon is stout and erect. They are known only from the Recent.

Vespa crabro (European hornet, hornet, yellow-jacket; superfamily Vespoidea, family Vespidae) The largest social wasp, similar in appearance to the common wasp, but up to 35 mm long, which often nests in old trees, is a fierce predator, and is common throughout Europe and has now spread to America. The common name 'hornet' is sometimes

used loosely to refer to all members of the subfamily Vespinae.

Vespa orientalis (superfamily Vespoidea, family Vespidae) Species of large wasps, marked with chocolate brown and yellow, whose queens and workers are major pests of honeybees, raiding parties destroying the honeybee workers. The species is distributed from the E. Mediterranean eastwards, where it replaces *Vespa crabro*. The venom of the females has been the subject of long-term pharmacological study.

Vespertilionidae (bats; order Chiroptera, suborder Microchiroptera) Family of insectivorous bats in which the nose is usually simple, the tail extends to the edge of the uropatagium, the ears are simple and usually immobile. Some forms have long ears and narial pads on the nose. *Tylonycteris* has sessile adhesive pads on all limbs. *Pipistrellus pipistrellus* is the common pipistrelle bat. The family has a worldwide distribution, except for the arctic and antarctic regions. There are 42 genera, with about 320 species.

Vespidae (suborder Apocrita, superfamily Vespoidea) The principal family of social wasps, containing many common species, whose members are social, predatory, and more or less melliferous (producing honey). Females can often inflict painful stings. The forewings, which have a very long discoidal cell, are usually folded longitudinally at rest, and the hind wings possess a jugal lobe. Mandibles are usually short and broad, with overlapping apices. Most species are black and yellow with banded abdomens and yellow or white facial markings. Members of some subfamilies feed their young on pre-chewed insects, and make their nests of a papery cellulose construction; other subfamilies are solitary wasps, provisioning their nests with paralysed prey. *See* hunting wasp.

Vespula austriaca (cuckoo wasp; superfamily Vespoidea, family Vespidae) Species of wasp which is a social parasite of other congeneric, paper-making wasps, especially of *V. rufa*. *V. austriaca* lacks a worker caste and the females invade colonies of other species, laying eggs in the brood cells in order that the young will be reared by the host workers.

Vespula germanica (German wasp; superfamily Vespoidea, family Vespidae) One of two common paper-making species of wasps that occur in Britain and W. Eurasia. They make large, circular nests in loft spaces or below ground. The species has been accidentally introduced into N. America, Australia, and New Zealand, where it has attained pest status. Its ability to utilize humans as a means of dispersal is shown by its appearance on several remote oceanic islands.

vestigial organs Atrophied or non-functional organs that are well developed and fully functional in other members of the group. They result from the adoption of a way of life in which the organs are no longer required. For example, rudimentary pelvic bones are found in some whales, but are no longer required since whales have no hind limbs as such. Such features are difficult to reconcile with the concept of special creation.

vetches *See Vicia*.

viability The probability that a fertilized egg will survive and develop into an adult organism. Often applied to plant germination experiments with comparisons across phenotypic classes under standard specific environmental conditions.

Vibrio (family Vibrionaceae) Genus of bacteria in which the cells are straight or curved rods, and typically have one or more flagella at one end. They are chemo-organotrophic, and can grow in the presence or absence of air. They are found in aquatic environments and in the intestines of humans and other animals. The genus includes some important pathogens, e.g. the causal agent of cholera.

Vibrionaceae Family of Gram-negative bacteria in which the cells are straight or curved rods, and are typically motile with one or more flagella at one end. There are several genera, found as saprotrophs in freshwater or marine environments, but the family also includes some important human pathogens.

vibrissae 'Whiskers'. In most Mammalia, and in many other animals, stiff hairs or modified feathers projecting from the face and in some species from the limbs, vibration of which stimulates nerve sensors in the skin.

vicariad *See* vicariance.

vicariance (vicariad, vicarious species) The geographical separation of a species so that two closely related species or a species pair result, one species being the geographical counterpart of the other. There are many examples in the floras of N. America and Eurasia.

vicariance biogeography A new school of biogeographical thought, derived from Croizat's panbiogeography. Supporters of this school maintain that the distribution of organisms depends on their normal means of dispersal; e.g. disjunctions are explicable in terms of new barriers (rivers, rises in sea-level, etc.) having split formerly continuous ranges, rather than in terms of the organisms hopping over already existing barriers. Thus they reject sweepstakes routes and similar concepts, postulating instead former land bridges and even vanished continents where there is sufficient coincident plant and animal distribution.

vicarious distribution Closely related species pairs derived from a common ancestor are described as vicarious, and when the one species replaces the other geographically (as opposed to ecologically) they are described as having a vicarious distribution. There are many animals and herbaceous plants with a vicarious distribution between N. America and Europe. In zoology, subspecies are conspecific vicariants.

vicarious species *See* vicariance.

Vicia (vetches; family Leguminosae) Genus of herbs, most of which climb by means of leaf-tendrils. The leaves are usually pinnate, in several

pairs, with no terminal leaflets. The flowers are in axillary racemes, and have an obliquely truncate stamen-tube. The style is normally cylindrical, and either hairless or downy all round, and bearded below the stigma (in the similar genus *Lathyrus* the style is flattened, and bearded on its upper side). The pods are two-valved, flattened, and contain several seeds in each. *Vicia faba* (broad bean) is an important vegetable, *V. sativa* (common vetch) an important fodder plant. There are some 150 species, mostly northern temperate, but also occurring in S. America.

Vicia faba (broad bean) *See Vicia*.

Vicia sativa (common vetch) *See Vicia*.

Victoria (family Nymphaeaceae) Genus of one species (*V. amazonica*) of water-lily, famous for its enormous, almost circular leaves, up to 2 m across with radial rims, which occurs in rivers and lakes in the Amazon region. The plant was known formerly as *V. regia*, but *amazonica* is the oldest specific name.

vicuña (*Lama vicugna*) *See* Camelidae.

vigilance The readiness of an animal to respond to unpredictable events in its environment.

Vigna (family Leguminosae) Genus of vetch-like, twining herbs, usually with three leaflets, and with showy flowers grouped on long peduncles. Nine of the stamens are joined below, one is free. The style has a line of hairs along one side only. The pods are not flattened. There are several hundred species, prominent in the African, semi-arid tropics.

Villafranchian A mammalian age which is dated at base at approximately three million years ago. It lasted an estimated two million years and therefore transgresses the Late Pliocene/Early Pleistocene boundary.

Vinca (periwinkle; family Apocynaceae) Genus of seven species of creeping shrubs or perennial herbs, found in Europe and W. Asia.

Vincent's angina (trench mouth) Ulcerative condition of the mouth which appears to be caused by bacterial infection, although the identity of the species responsible is uncertain.

vinegaroon *See Mastigoproctus giganteus*.

Viola (pansy, violet; family Violaceae) Genus of dicotyledonous herbs with simple alternate or basal leaves. The flowers are zygomorphic, with five sepals and five petals, the lower two often fused, with prominent guide lines and a contrasting centre. Many species have been domesticated and hybridized to produce the showy pansies grown in garden borders. There are about 500 species.

Violaceae Family of dicotyledonous herbs, and some shrubs and trees, in which the leaves are simple and stipulate. The flowers are usually solitary, though sometimes in racemes, mostly irregular, with five free sepals, petals, and stamens, and the corolla is frequently spurred. The superior ovary is one-celled, with usually three parietal placentae, with a single, often curved and thickened style. Modern classifications recognize some 16 genera, with 800 species, found throughout much of the world. *Viola* (violets, pansies), of herbs with alternate leaves and spurred corollas, is the largest genus and is mainly temperate. Various species are cultivated for their attractive flowers.

violet *See Viola*; and Violaceae.

Vipera (vipers; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Genus of venomous snakes in which the head is moderately large, and broader than the neck, and there is a short, conical tail. Body scales are strongly keeled, the anal shield is undivided, and subcaudal plates are paired. The eyes have vertical pupils. There are about 15 species, occurring in Europe, Africa, and Asia.

Vipera ammodytes (horned viper, long-nosed viper, nose-horned viper, sand viper; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Venomous snake which is stockily built with a protruding horn on the snout. Its maximum length is 95 cm. It possesses a thick dorsal zigzag. It is ovoviviparous. It occurs in S. Austria, NE Italy, the Balkans, and SW Asia.

Vipera aspis (asp, aspic viper, asp viper; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Venomous snake which grows to a maximum length of 85 cm. The snout is slightly raised. It has a dorsal pattern of cross-bars, or more rarely a zigzag. It is ovoviviparous (4–18 young). It inhabits dry places in France, Switzerland, and Italy. Probably it is extinct in Germany.

Vipera berus (adder, common viper, northern viper, viper; order Squamata, suborder Serpentes (Ophidia), family Viperidae) Venomous snake whose average length is 55 cm. It may be grey, brown, or reddish in colour, with a darker, dorsal zigzag. Melanism is frequent. Its diet consists mainly of small mammals and lizards. It is ovoviviparous (3–20 young). Its habitat is variable. It occurs in the British Isles (but not Ireland), Europe, and temperate Asia.

viperfish *See* Chauliodontidae.

Viperidae (vipers; order Squamata, suborder Serpentes (Ophidia)) Family of compact, sturdy snakes, most of which have a broad triangular head, small ridged scales, a short tail, and drab coloration. Their venom is generally haemotoxic (blood-poisoning) and is injected down hollow fangs, which rotate back against the palate when the mouth is closed. There are about 100 species, occurring in Europe, Asia, and Africa. *See Bitis arietans*; *Bitis nasicornis*; *Vipera aspis*; and *Vipera berus*.

viperine snake *See Natrix maura*.

vipers *See Bitis arietans; Bitis nasicornis; Vipera*; *Vipera ammodytes*; *Vipera aspis*; *Vipera berus*; and Viperidae.

viraemia The condition in which viruses are present in the blood.

Vireo (vireos; family Vireonidae) Genus of small, grey, brown, green, and yellow birds, many with pale wing bars, which have fairly stout, slightly

hooked bills. Their eyes are often white or red. They inhabit forests, feed on insects and fruit, and nest in trees and bushes. There are 25 species, many migratory, found in N., C., and S. America.

Vireolaniidae (shrike-vireos) *See* Vireonidae.

Vireonidae (vireos; order Passeriformes) Family of small, brown, green, grey, and yellow birds, many of which have pale supercilia and wing bars. Their bills are medium to long, stout, and slightly hooked. They have long and pointed to short and rounded wings. They are arboreal, inhabit forests, feed on insects and fruit, and nest in trees and bushes. There are four genera, with about 45 species, many migratory, found in N., C., and S. America. Two groups, included here, are often regarded as separate families: Cyclarhidae (pepper-shrikes) and Vireolaniidae (shrike-vireos).

vireos *See Vireo*; and Vireonidae.

virga From the Latin *virga* meaning 'rod'. 1 A thin rod. Several virgae, usually made of hazel, and tied in bunches, are used for hurdles in building and in thatching. 2 Supplementary cloud feature referring to the trails of precipitation falling from the under surface of cloud but not reaching the ground. This phenomenon (known in English as 'fall-stripes') is often seen with cumulus, cumulonimbus, altocumulus, stratocumulus, cirrocumulus, nimbostratus, and altostratus. *See also* cloud classification.

Virginia creeper *See Parthenocissus*.

virion Individual virus particle.

viroid Piece of infectious nucleic acid. Viroids appear to resemble viruses in some respects, but consist only of small, closed circles of RNA: there is no capsid. They can cause disease in plants, e.g. potato spindle tuber disease, and hop stunt.

Virola (family Myristicaceae) Genus of plants some of which are big trees and an important source of timber (banak). There are 60 species occurring in central and southern regions of tropical America.

virtual blastopore *See* blastopore.

virulence The capacity of a pathogenic organism to cause disease or damage in an infected host.

virulent phage Phage that causes the destruction of the host bacterium by lysis. Temperate phages on the other hand rarely cause lysis.

virus Type of non-cellular 'organism' which has no metabolism of its own. It consists mainly or solely of a nucleic acid genome (RNA or DNA) enclosed by protein; in some cases there is also a lipoprotein envelope. In order to replicate (multiply), a virus must infect a cell of a suitable host organism where it redirects the host-cell metabolism to manufacture more virus particles. The progeny viruses are released, with or without concomitant destruction of the host cell, and then can infect other cells. All types of organism, from bacteria to humans, are susceptible to infection by viruses; virus infections may be asymptomatic or may lead to more or less severe disease. Some human diseases caused by viruses include chickenpox, common colds, measles, and rabies.

visceral arch In Gnathostomata, one of a series of inverted cartilaginous or bony arches between the mouth and throat, forming partitions between adjacent gill slits.

viscotaxis Change in direction of locomotion in a motile organism or cell made in response to a change in the viscosity of the surrounding medium.

Viscum (mistletoe) *See* Loranthaceae.

visible In genetics, applied to a mutant whose phenotype may actually be observed, as opposed to lethals, whose occurrence may only be inferred from the absence of an expected class of individuals in the progeny of a cross designed to detect induced mutants.

visna Disease of sheep in which symptoms begin with abnormal movements followed by progressive paralysis and death. The causal agent is a virus of the Retroviridae. The disease occurs in Iceland.

visual purple *See* rhodopsin.

vital stain Stain capable of entering and staining a living cell without causing it injury.

vitamin Organic compound required in minute quantities by heterotrophic organisms for their normal health and development (hence the origin of the name, from 'vital amino') but which they cannot themselves synthesize. Vitamins are distinct from carbohydrates, fats, proteins, and nucleic acids. They, or their derivatives, normally have a coenzyme function and their absence from the diet or their inadequate absorption from the gut gives rise to specific deficiency diseases.

vitamin A *See* retinol.

vitamin B_1 *See* thiamine.

vitamin B_2 *See* riboflavin.

vitamin B_3 *See* pantothenic acid.

vitamin B_{12} *See* cobalamine.

vitamin C *See* ascorbic acid.

vitamin D *See* calciferol.

vitamin E *See* tocopherol.

vitamin K Generic term for 2-methyl-1,4-naphthoquinone and its derivatives; fat-soluble vitamins required for the synthesis of prothrombin and also for other clotting factors necessary for its activation. A deficiency of this vitamin causes delayed clotting, and haemorrhaging.

vitelline membrane Membrane that surrounds the ovum of animals, from which it has been secreted —in birds, for example, this is the membrane surrounding the yolk of the egg. In *Drosophila* the term is used rather specifically for the membrane that immediately surrounds the plasma membrane of the ovum. In this case it is formed by the fusion of deposits in the intercellular space between the oocyte and columnar follicle cells that surround it.

vitrodentine *See* placoid scale.

vitta *See* Umbelliferae.

Viverridae (civets, genets, mongooses; order Carnivora, suborder Fissipedia, superfamily Feloidea) Family of primitive, short-legged, long-bodied, mainly nocturnal carnivores occupying in

the Old World tropics the ecological position occupied in temperate regions by the Mustelidae. The Viverridae resemble closely the miacids of the Oligocene, from which they are descended. Their fossil record is sparse, but extends back to the Eocene. Some modern forms are strongly reminiscent of felids, especially *Cryptoprocta* of Madagascar, which perhaps is better classified as a felid. The claws are partly retractile, and the gait is semiplantigrade or digitigrade. The canine teeth are smaller than those of most carnivores, and the carnassials are not well developed. The skull and face are long, and the brain small. Most feed on small vertebrates and invertebrates, but some eat plant material. Viverrids are distributed widely throughout the Old World tropics and subtropics and are the only carnivores to have become established in Madagascar. There are 36 genera, with about 75 species.

vivianite Mineral, specific gravity 2.9, hardness 1.5–2.0, and with the chemical composition $Fe_2(PO_4)_2.8H_2O$. It occurs in phosphorus-rich, sedimentary iron ores and peat bogs, and in association with siderite, and in a reducing environment with organic remains present. It is distinguished by its radial, acicular crystals, stellate form, and close association with fossil bones and shells. It is greyish-blue or occasionally colourless, and has a vitreous lustre. It crystallizes in the monoclinic system. The crystals are prismatic, rod-like, acicular, and stellate masses. It is used as a cheap blue pigment.

viviparous 1 Producing living young rather than eggs. The growth of the embryo occurs within the mother's body which nourishes it via a placenta. Viviparity occurs in placental mammals, and in a few other animals. 2 Bearing seeds that germinate within the fruit from which they obtain nourishment (e.g. mangroves), or producing shoots for vegetative reproduction rather than an inflorescence (e.g. some grasses).

viviparous lizard *See Lacerta vivipara*.

vizcacha *See* Chinchillidae.

vocalization The production of sound by the passage of air across vocal cords.

volatile One of the naturally occurring gases and liquids which become volatile when a magma reaches the Earth's surface or a zone of reduced pressure. Common volatiles include water vapour, carbon dioxide, hydrochloric acid, and sulphur dioxide, and there are many more.

volcanic bomb Rounded, spindle-shaped mass of volcanic rock that was molten when blasted from the vent and that achieved its shape by cooling and spinning as it fell to the ground.

volcanic dust Dust, ash, or other particulate matter commonly suspended in the atmosphere after volcanic eruptions. After explosive eruptions the dust may be thrown to heights of 20–30 km or more; it then takes a few years to fall out and may spread as a veil in the stratosphere over much of the Earth.

volcanic neck *See* volcanic plug.

volcanic plug (volcanic neck) Cylindrical filling of an ancient volcano, which due to its greater resistance, may be preserved after the volcanic edifice has been eroded away. *See also* puy.

volcano Naturally occurring vent or fissure at the Earth's surface through which pour molten, solid, and gaseous materials. The viscosity, gas content, and rate of extrusion of the magma probably determine the shape of the mountain built by eruptions from a central vent. Types of eruptions are named after volcanoes associated with them, as: (a) Hawaiian, producing very mobile lava, sometimes in fountains, with little explosive activity, forming a broad, low-angle cone (a shield volcano); (b) Strombolian, producing frequent, small eruptions, more acid magma, and a more steeply sided cone of interbedded lava and tephra; (c) Vulcanian, producing infrequent eruptions of more viscous magma; (d) Vesuvian, producing very explosive eruptions in which a plug of viscous lava in the vent is ejected; and (e) Peléan, in which rhyolite spines are extruded and nuées ardentes are released.

vole *See* Cricetidae.

voluntary behaviour In ethology, non-habitual behaviour that is associated with the somatic nervous system or (possibly in some species) with operant control of the autonomic nervous system.

volunteer plant Plant that has resulted from natural propagation, as opposed to having been deliberately planted by humans.

volva (mycol.) Cup-like sheath surrounding the base of the stipe in some agaric fruit bodies; the volva is a remnant of the universal veil after the rupture of the latter.

Volvocales (class Chlorophyceae) Order of green algae in which the vegetative cells are motile with flagella. They may be unicellular or colonial, and are found mostly in freshwater habitats, particularly those rich in nitrogen. There are several families, and genera include *Chlamydomonas* and *Volvox*.

Volvox (family Volvocaceae, order Volvocales) Genus of green algae in which the cells occur in spherical colonies (coenobia) of 500 to many thousands of cells, according to species. The genus is the most highly evolved of the order, showing considerable complexity in morphology and sexual reproduction. It is found in various aquatic habitats: puddles, ponds, ditches, lakes, etc.

Vombatidae (Phascolomyidae; wombats; order Marsupialia, superfamily Phalangeroidea) Family of large, burrowing, largely nocturnal marsupials in which the incisors and cheek teeth grow continually. The body is broad and flattened; the head large and flat; the limbs pentadactyl, short and stout, with broad, naked soles to the feet. The tail is vestigial. Wombats occur in S. and SE Australia, Flinders Island, and Tasmania. There are three species, *Vombatus ursinus* (common wombat), *Lasiorhinus latifrons* (hairy-nosed wombat), and *L. barnardi* (Queensland hairy-nosed wombat), of which only 40 individuals are known to be surviving at present.

vug (vugh) Cavity in a rock, which may contain a lining of crystalline minerals.

vugh *See* vug.

vulcanicity (vulcanism) All the processes associated with the transfer of magma and volatiles from the interior of the Earth to its surface. Current vulcanicity is confined to regions of the Earth where lithospheric plates converge, diverge, or pass over possible mantle hot-spots.

vulcanism *See* vulcanicity.

Vulpes (fox) *See* Canidae.

Vultur (Andean condor; family Cathartidae) Monotypic genus which comprises *V. gryphus*, the largest bird of prey. This is black with silvery-white secondaries and secondary coverts, and a white ruff around its neck; its head is bare and pink, with a large forehead wattle. It inhabits open country from mountains to coastal areas, feeds on carrion, and nests on ledges. It is found in S. America.

vultures 1 *See* Falconiformes. 2 *See Gyps*. 3 (New World vultures) *See* Cathartidae. 4 (Old World vultures, palm nut vulture, *Gypohierax angolensis*) *See* Accipitridae. 5 *See Teratornis incredibilis*.

W

waders *See Calidris*; Charadriidae; and Charadriiformes.

wadi The Arabic term for an arroyo.

waggle dance *See* dance language; and Nasanov's gland.

wagtails *See Motacilla*; and Motacillidae.

Wahlenbergia (Australian bluebell; family Campanulaceae) Genus of small herbs with alternate or opposite leaves which are sometimes toothed. The blue, solitary flowers are held on long stalks with five sepals, and a five-lobed, bell-shaped corolla. There are five stamens, and a three-lobed stigma. The capsule is urn-shaped, and splits into three to release the numerous, very fine seeds. Many species are annuals, and many are cultivated. There are more than 150 species found in southern temperate regions, of which 13 are endemic to Australia.

waldgrenze *See* timber-line.

walking catfish (*Clarias batrachus*) *See* Clariidae.

walking leaves *See* Phasmatodea; and Phylliidae.

walking sticks *See* Phasmatidae; and Phasmatodea.

wallaba (*Eperua falcata*) *See Eperua*.

wallaby *See* Macropodidae.

Wallace, Alfred Russel (1823–1913) English naturalist who was a contemporary of Charles Darwin. He worked in the E. Indies, and as a result of his observations there came independently to the theory of natural selection. His ideas were presented together with those of Darwin in a joint paper to the Linnean Society of London on 1 July 1858. *See also* Wallace's Line.

Wallacea *See* Wallace's line.

Wallace's line Important zoogeographical division which separates the Oriental and Notogaean zoogeographical regions. Alfred Wallace, a zoogeographer and contemporary of Charles Darwin, first demarcated the boundary between the Oriental faunal region and the Australasian region with its distinctive marsupials. The boundary is known to this day as Wallace's line. There is a zone of mixing called 'Wallacea', and strictly the line defines the extreme western limit of Australasian mammals, and the eastern limit of the main oriental fauna.

wallcreeper (*Tichodroma muraria*) *See* Tichodromadidae.

walleye (*Stizostedion vitreum*) *See* Percidae.

wall lizard *See Podarcis muralis*.

wall pressure The pressure exerted by the cell wall against the cell sap; it is equal to, but opposes, turgor pressure.

walnut (*Juglans regia*) *See Juglans*.

walrus (*Odobenus rosmarus*) *See* Odobenidae.

wandering albatross (*Diomedea exulans*) *See Diomedea*.

wandering jew (*Tradescantia*) *See* Commelinaceae.

wapiti (red deer, American elk, *Cervus elaphus*) *See* Cervidae.

warble fly *See* Gasterophilidae; and Oestridae.

warblers **1** *See Geothlypis*; and *Hippolais*. **2** (bush warblers) *See Cettia*. **3** (cisticolas) *See Cisticola*. **4** (grasshopper warblers) *See Locustella*. **5** (Kirtland's warbler, *Dendroica kirtlandii*) *See Dendroica*. **6** (leaf warblers) *See Phylloscopus*. **7** (New World warblers) *See* Parulidae; and *Vermivora*. **8** (Old World warblers) *See Sylvia*; and Sylviidae. **9** (prinias) *See Prinia*. **10** (reed warblers) *See Acrocephalus*. **11** (thornbills) *See Acanthiza*; and Acanthizidae. **12** (titwarblers, *Leptopoecile*) *See* Regulidae. **13** (woodwarblers) *See Basileuterus*. **14** (yellow warbler, *Dendroica petrechia*) *See Dendroica*.

warehou (*Seriolella brama*) *See* Centrolophidae.

warm-blooded *See* homoiotherm.

warm front Surface where advancing warm air displaces colder air, e.g. in mid-latitude depressions where, owing to the convergence of the air masses and the difference of density between them, the warm air tends to rise over the cold air. Slopes of warm fronts are typically less than 1 : 100 and the ascent of air is gradual. Stratiform cloud develops in the rising air. High cirrus cloud followed by lower and thickening altostratus indicate, the approaching front. As the frontal contact with the ground approaches, heavy nimbostratus and much rain may occur. Passage of the front is marked by a rise of temperature, clearing of precipitation, and (in the northern hemisphere) the wind veering typically from south or south-easterly to south-westerly.

warm rain Rain, resulting from the coalescence of droplets, in clouds that are unfrozen (i.e. their upper parts are not at freezing level).

warm sector Tongue of relatively warm air of tropical or old polar or maritime origin appearing between colder air masses. Such a tongue occupies the area between the warm and cold fronts in a developing mid-latitude depression. Within the warm sector, pressure, wind, and temperature remain fairly steady. Cloud and precipitation depend on the precise condition of the generally stable air; cloud may be produced from orographic uplift or fog from passage over a cool sea surface.

warning coloration *See* aposematic coloration.

warping Traditional farming practice in which a river is permitted to flood low-lying ground

temporarily in order to supply silt in which crops can be grown without irrigation.

warp soil Soil consisting principally of silt deposited on land by deliberate flooding (warping).

warren Land, which may be adjacent to a forest and enclosed, that is, or was formerly, used by humans for the keeping of rabbits.

wart Small, non-malignant tumour of the skin caused by viruses of the papillomavirus group.

warthog louse (*Haematomyzus hopkinsi*) *See* Rhyncophthirina.

wart snakes *See* Acrochordidae.

warty angler *See* Brachionichthyidae.

warty newt See *Triturus cristatus*.

washboard moraine *See* moraine.

Washingtonia (family Palmae) Genus of palms which are hardy and are cultivated. The leaves are fan-like, and persistent as a shaggy, brown petticoat investing the trunk. The flowers are hermaphrodite, with a single trilocular ovary. The fruit contains one seed. There are two species, one occurring in California, the other in Mexico.

washover delta Fan-shaped body of sediment transported landward by marine waters flowing through or across a coastal barrier such as a barrier bar or island. Such bodies are formed especially during storms when the barriers are likely to be overtopped.

washplain Nearly flat surface made up of alluvium mantling a thick layer of deeply weathered bedrock and found in the savannah environment. It is washed by seasonally flooding streams which are unable to incise due to the lack of abrasive bedload and the large volume of sediment.

wasps **1** *See* Apocrita; Bethylidae; Cleptidae; Dryinidae; Encyrtidae; Figitidae; gall wasps; Hymenoptera; Gasteruptiidae; Masaridae; paper wasps; Platygasteridae; Pteromalidae; Rhopalosomatidae; Scolliidae; social wasps; solitary wasps; Tiphiidae; *Vespa orientalis*; and Vespidae. **2** (chalcid wasps) *See* Chalcidae; Chalcidoidea; Eulophidae; Leucospidae; Torymidae; and Trichogrammatidae. **3** (cockroach wasp) *See* Ampulicidae. **4** (cow killer) *See Dasymutilla occidentalis*. **5** (cuckoo wasp) *See Vespula austriaca*. **6** (ensign wasps) *See* Evaniidae. **7** (fig wasps) *See* Agaonidae. **8** (gall wasps) *See also* Cynipidae. **9** (German wasp) *See Vespula germanica*. **10** (heath potter wasp) *See Eumenes coarctata*. **11** (hornet) *See Vespa crabro*. **12** (ichneumon wasps) *See* Braconidae; and Ichneumonidae. **13** (mason wasps) *See* Eumenidae. **14** (mule killer) *See Dasymutilla occidentalis*. **15** (potter wasps) *See* Eumenidae. **16** (ruby-tailed cuckoo wasps, ruby-tailed wasps) *See* Chrysididae. **17** (spider-hunting wasps) *See* Pompilidae. **18** (velvet ants) *See* Mutillidae. **19** (woodwasps) *See* Orussidae; Siricidae; and Symphyta. **20** (yellowjacket) *See Vespa crabro*.

wasp waist (petiole) The constriction at the base of the abdomen in the Apocrita (the suborder of Hymenoptera comprising the ants, bees, and wasps). The degree of constriction is varied, ranging from slight to extreme with elongation.

waste **1** Unenclosed land used for common pasture. **2** Unlicensed felling of trees. **3** Over-exploitation of woodland or wood-pasture or the failure to enclose coppice after felling, resulting in stock being allowed to graze to the detriment of the undergrowth.

water beetle *See* Hydrophilidae.

water boatman *See* Notonectidae.

water chestnut (*Eleocharis tuberosus*) *See Eleocharis*.

watercress *See Nasturtium*.

water dog *See Necturus maculosus*.

water-dropworts See *Oenanthe*.

water flea *See* Cladocera.

waterfowl *See* Anseriformes.

water hyacinth (*Eichhornia crassipes*) *See Eichhornia*; and Pontederiaceae.

water 'lice' *See Gammarus*; and Amphipoda.

waterlilies *See Nymphaea*; and Nymphaeaceae.

waterlogged Saturated with water.

water milfoils *See Myriophyllum*.

water mould An aquatic fungus; sometimes specifically a fungus of the order Saprolegniales.

water pipit (*Anthus spinoletta*) *See Anthus*.

water potential The difference between the energy of water in the system being considered and of pure, free water at the same temperature. The water potential of pure water is zero, so that of a solution will be negative. If there is a gradient of water potential between two cells, water will diffuse down the gradient until equilibrium is reached.

water scorpion *See* Nepidae.

water spider *See Argyroneta aquatica*.

water-table The upper surface of ground water or the level below which the material is permanently saturated with water. *See also* vadose.

water vapour The gaseous form of water present in the atmosphere in varying amount. It is an intermediate stage in the hydrological cycle. Water vapour in the atmosphere represents 0.001% of the total water inventory of the Earth. Water molecules have a short residence time in the atmosphere, on average about nine days, though this varies over a very wide range from a few minutes or hours upwards. Water enters the atmosphere by evaporation, transpiration, and sublimation at the Earth's surface. Concentration of vapour decreases with increasing altitude up to over 20 km, where some increase may occur. Measures of water-vapour concentration include vapour pressure, the humidity mixing ratio, and the absolute and relative humidity. The physical significance of water vapour in the atmosphere is in its condensation to produce cloud and precipitation (with release of latent heat of condensation, which often accelerates the uplift of rising air), its absorption and scattering of radiation, etc.

water vascular system *See* Echinodermata.

Watson–Crick model The currently accepted model for the structure of DNA, as proposed by Watson and Crick (1953). It is suggested that DNA is composed of two right-handed, antiparallel polynucleotide chains coiled around a common axis to form a double helix. This structure is maintained by hydrogen bonds formed between the chains through the base pairing of adenine to thymine and cytosine to guanine.

wattle In birds, a bare, fleshy area of skin, often highly coloured and pendulous, usually hanging from the gape, around the eye, or on the throat. Wattles are used mainly in display and some are moulted annually.

wattlebirds *See* Callaeidae.

wattled broadbill (*Eurylaimus steerei*) *See Eurylaimus*.

wave Periodic disturbance in a solid, liquid, or gas, or in space, as energy is transmitted through the medium. In water, waves occur at the surface. The size of the wave varies from minute capillary waves to massive tsunami, while wave period ranges from a few seconds to several hours.

wave base Depth beneath a water mass below which wave action ceases to disturb the sediments. It is the lowest limit of orbital motion of water particles beneath waves. Wave-base depth is approximately equal to half the wavelength of the surface waves.

wave clouds Clouds occurring in an airstream characterized by wave motion, usually after passing over a mountain barrier. Lenticular (lens-shaped) clouds and cloudlets appearing stationary in the crests of the waves are a characteristic sight in climates of the lee side of mountain barriers, e.g. in E. Scotland and Sweden.

wave-cut bench *See* shore platform.

wave-cut platform *See* shore platform.

wave depression Low pressure area developed at the apex of a developing wave distortion along a front. A series of such systems is typical of mid-latitude depression sequences.

wavellite Secondary mineral, specific gravity 2.3–2.4, hardness 3.5–4.0, chemical composition $Al_3(PO_4)_2(OH)_3.5H_2O$, named after the eighteenth century British mineralogist W. Wavell, who discovered it. It is found on joint surfaces and cavities in rock, especially slates and shales, and in association with limonitic ore bodies. Its radiating habit is its most diagnostic feature. It is normally white, but often greenish, yellow, grey, or brown, and it has a vitreous lustre. It crystallizes in the orthorhombic system. It normally forms fibrous, radiating aggregates, or hemispherical or globular aggregates.

wave period The time required for two successive wave crests to pass a fixed point, or the time for a single wave crest to travel a distance equal to the length of the wave.

wave refraction Process by which the direction of waves moving in shallow water at an angle to the submarine contours is altered. The part of the wave train travelling in shallower water moves more slowly than that still advancing in deeper water. The wave crests therefore turn to become more parallel with the submarine contours as they approach the coast.

waverer A young tree that is left standing after coppice wood has been cut.

wave ripple marks *See* oscillation ripple.

wave spectrum Concept used to describe mathematically the distribution of wave energy (the square of the wave height) with wave frequency. Using this concept a highly confused pattern of interfering waves can be divided into its constituent wave-forms. The results can be used as an aid to wave forecasting.

waves *See* Geometridae.

waxbills *See Amandava*; and Estrildidae.

wax cap Common name for the waxy, typically brightly coloured, fruit bodies of fungi of the family Hygrophoraceae.

wax flowers *See Eriostemon*.

waxwings *See Bombycilla*; and Bombycillidae.

weakening In synoptic meteorology, a decrease in pressure gradient around a pressure system over time. Changes of this kind bring about a weakening of the winds. *See also* intensification.

Wealden Name given to a sequence of freshwater deposits in the British Cretaceous System. In Sussex and Kent the Wealden consists of two major sedimentary units: the Hastings Beds Group and the Weald Clay Group. Of the two the first is the lower and more sandy unit, whereas the second is mud-dominated.

wearyfish *See* Scopelosauridae.

weasel (*Mustela*) *See* Mustelidae.

weatherfish (*Misgurnis fossilis*) *See* Cobitidae.

weathering All the physical, chemical, and biological processes (e.g. wind, water, ice, and chemical action) that cause the disintegration of rocks and partially consolidated mineral materials at or near the land surface. The process involves little or no transport. The combined effects of weathering and erosion are called 'denudation'.

weathering front The junction between chemically weathered rock or regolith and sound rock. Where the front lies between regolith and unweathered bedrock it may be exposed by subsequent erosion to form an etchplain.

weather report A record of observations of meteorological values and the state of the weather made at a given place and time.

weather satellite Satellite that senses the state of the atmosphere, e.g. by photographing cloud distribution and by using infra-red photography to record cloud temperature as an indication of the height of the cloud tops.

weaver ant *See Oecophylla longinoda*.

weavers *See* Ploceidae; and *Ploceus*.

Weberian apparatus *See* Weberian ossicles.

Weberian ossicles (Weberian apparatus) Structures found in bony fish belonging to the orders Cypriniformes and Siluriformes, and derived from the first four vertebrae. They form a link between the inner-ear region and the swim-bladder, facilitating sound reception. *See also* Ostariophysi.

Weber's line Line of supposed 'faunal balance' between the oriental and the Australasian faunal regions within Wallacea.

wedding bush *See Ricinocarpus*.

wedge *See* ridge.

weed Plant that is not cultivated deliberately by humans but that grows entirely or predominantly in situations disturbed by humans.

weeverfish *See* Trachinidae.

weevil 1 *See* Apionidae. 2 *See* Curculionidae.

Wegener, Alfred *See* continental drift.

Weichselian *See* Devensian.

Weil's disease (infectious jaundice) Form of leptospirosis in which jaundice is a prominent symptom. *See Leptospira*.

Weinmannia (family Cunoniaceae) Genus of trees in which the leaves are opposite, pinnate, with big stipules, and the leaflets toothed. The flowers are tiny, with four petals, eight stamens, and the ovary superior and bilocular. The fruit is a capsule. There are 170 species, occurring in Madagascar, the Mascarenes, from Malaysia to New Zealand and the Pacific islands, and from Mexico to Chile.

Weismann, August (1834–1914) German biologist who established the improbability, if not impossibility, of the inheritance of acquired characteristics, as required by Lamarck's theory of adaptation.

Wellingtonia (*Sequoiadendron giganteum*) *See Sequoiadendron*; and Taxodiaceae.

wels *See* Siluridae.

Welwitschia The sole genus, with only one species (*W. bainesii*) of the remarkable gymnosperm family Welwitschiaceae (related to Ephedraceae and Gnetaceae) of the deserts of SW Africa. It has a barrel-like stem with a deep tap root, bearing on its rim big, tattering, strap-like leaves, and flowers which are small, dioecious, and covered by bracts, with the single, erect ovule within the perianth tube of the female flower.

Wenlock (Wenlockian) The stratigraphic name given to the Middle Silurian succession throughout Europe. Reef-dwelling organisms abound on the bedding planes of the Wenlock limestone of the Welsh borderlands.

West African rainforest floral region Part of Good's (1974) African subkingdom, within his Palaeotropical kingdom, which contains a rich but poorly documented flora which has provided some valuable economic plants, e.g. *Coffea liberica*, and others of more local importance, including timber trees.

west and central Asiatic floral region Part of Good's (1974) Boreal kingdom, which contains a limited, specialized flora, because much of the region comprises dry mountains and deserts. There are about 150 endemic genera, virtually all small. Barley and some types of wheat probably originated in this region.

West Australia current The oceanic current that flows north along the W. Australian coast. The flow is strong and steady in summer, but is much reduced during the winter months. Low salinity (34.5 parts per thousand) and low temperature (3–7 °C) typify the waters of this current.

West Australian rainbowfish (*Nematocentris australis*) *See* Melanotaenidae.

westerlies Popular term for the prevailing, eastward-moving airstreams in the mid latitudes of the northern and southern hemispheres.

western red cedar (*Thuja plicata*) *See Thuja*.

western whip snake *See Coluber viridiflavus*.

Westringia (family Lamiaceae) Genus of shrubs in which the leaves are held in whorls of three or four. The solitary flowers are white or blue, and axillary. The calyx is five-toothed, and the corolla a two-lipped tube, the lips lobed. The four stamens are paired, one pair being without anthers. The fruit is a schizocarp which splits into four small nutlets enclosed by the persistent calyx. Several species are cultivated. There are about 25 species, all endemic to Australia, and found in temperate regions.

West Wind Drift The largest and most important ocean current in the southern hemisphere. It flows in an easterly direction around Antarctica, and occupies a wide tract of water in the S. Pacific, S. Atlantic, and Indian Oceans. There is very little separation between surface- and bottom-water circulation within this area. The current is remarkably constant and is characterized by low salinity (less than 34.7 parts per thousand), cold (−1 to 5 °C) waters, and by large sea waves and swell.

wet-bulb depression The extent to which the temperature recorded by a ventilated wet-bulb thermometer falls below the dry-bulb air temperature.

wet-bulb thermometer A thermometer, the bulb of which is kept moist by a thin cloth (muslin) bag connected by a wick to a bath of clean (distilled) water. As long as the air is not saturated, evaporation from the muslin keeps the wet bulb at a lower temperature than the dry-bulb thermometer beside it, with which its readings are compared. The depression of the wet-bulb temperature gives a measure of the saturation deficit, and so of the relative humidity of the air.

wetlands General term applied to open-water habitats and seasonally or permanently waterlogged land areas, including lakes, rivers, and estuarine and freshwater marshes. Wetland habitats, especially marsh and bog areas, are among the most vulnerable to destruction since they can be drained

and reclaimed for agriculture or forestry, drained for pest control (e.g. to eliminate breeding grounds for malaria-carrying mosquitoes), or modified for water supply, flood control, hydroelectric-power schemes, waste disposal, etc.

wet rot Type of timber decay found only in wood with a high moisture content. It is caused by the cellar fungus, *Coniophora puteana*.

whale *See* Cetacea.

whale catfish *See* Cetopsidae.

whale lice (*Cyamus*) *See* Amphipoda; and Crustacea.

whaler shark *See* Carcharhinidae.

whale shark (*Rhincodon typus*) *See* Rhincodontidae.

wheatears *See Oenanthe*.

wheat stem sawfly (*Cephus pygmaeus*) *See* Cephidae.

wheel animalcules *See* Rotifera.

whimbrel *See Numenius*.

whinchat (*Saxicola rubetra*) *See Saxicola*.

whiplash Alternative, little-used word for flagellum.

whip-poor-will (*Caprimulgus vociferus*) *See Caprimulgus*.

whipscorpions *See* Ambypygi; and Uropygi.

whipspider *See* Amblypygi.

whiptail 1 *See* Macrouridae. 2 *See* Teiidae.

whiptail gulper *See* Saccopharyngidae.

whirligig beetle *See* Gyrinidae.

whirling psychrometer (sling psychrometer) Psychrometer with a handle, which allows rapid rotation of mounted wet- and dry-bulb thermometers to ensure air flow around the bulbs.

whirlwind Spiral wind storm around a low-pressure centre. In arid areas dust may be carried upward several hundred metres.

whisk ferns *See Psilotum*.

whistlers *See* Muscicapidae; and *Pachycephala*.

whistling ducks *See Dendrocygna*.

white ant *See* Isoptera.

white beam (*Sorbus aria*) *See Sorbus*.

white blister (white rust) *See* Albuginaceae.

white butterflies *See* Pieridae.

white-collared kingfisher (*Halcyon chloris*) *See Halcyon*.

white-crested laughing thrush (*Garrulax leucolophus*) *See Garrulax*.

white dolphin (*Sousa*) *See* Stenidae.

white-eyes *See* Zosteropidae; and *Zosterops*.

whitefaces *See* Acanthizidae.

whitefly *See* Aleyrodidae.

white-footed deer mouse (*Peromyscus leucopus*) *See* Cricetidae.

white lauan *See Parashorea*.

white meranti *See Shorea*.

white-out Meteorological condition in which low cloud appears to merge with a snow-covered surface to produce a uniform appearance in which outlines cannot be discerned.

white piedra Disease of hair caused by infection with a fungus of the genus *Trichosporon*. Pale-coloured nodules develop on the hairs, and infected hairs break easily.

white piranha (*Serrasalmus rhombeus*) *See* Characidae.

white rot 1 Disease of onions, shallots, and leeks, caused by the fungus *Sclerotium cepivorum*. Leaves of infected plants turn yellow, and a fluffy, white mycelium appears on the bulb. Small, black sclerotia can be seen in the mycelium and these can survive in the soil for many years. 2 Type of timber decay in which the wood becomes soft, white, and fibrous.

white rust 1 (white blister) Disease affecting crucifers and other plants, caused by species of the genus *Albugo*. White, blister-like spots are formed on the leaves, and infected plants may show some distortion. 2 Disease of chrysanthemums caused by *Puccinia horiana*. Buff or white pustules appear on the under-sides of the leaves and may become brown and necrotic. This disease first appeared in Britain in 1963 and is now a notifiable disease.

white seraya *See Parashorea*.

white shark (*Carcharodon carcharias*) *See* Lamnidae.

white stork (*Ciconia ciconia*) *See Ciconia*.

white sucker (*Catostomus commersoni*) *See* Catostomidae.

white-tailed sea eagle (*Haliaeetus albicilla*) *See Haliaeetus*.

white whale (beluga, *Delphinapterus leucas*) *See* Monodontidae.

white-winged guan (*Penelope albipennis*) *See Penelope*.

white-winged triller (*Lalage sueurii*) *See* Campephagidae.

whooping cough (pertussis) Acute, infectious disease which affects mainly children. It is caused by the bacterium *Bordetella pertussis*. Symptoms include respiratory catarrh and a dry cough which may become paroxysmal; 'whooping' occurs in the effort to breathe in.

whorl The arrangement in which leaves, petals, etc. all arise at the same point on an axis, encircling it.

whydahs *See Euplectes*.

Widdringtonia (family Cupressaceae) Genus of small to medium-sized, evergreen, cypress-like conifers with small, scale leaves arranged in pairs. The cones have only four scales. The timber of *W. juniperoides* (Clan William cedar) is very valuable and is used for high-quality furniture. Young trees

of *W. whytei* (Mlanji cedar) are used as a substitute for Christmas trees. There are five species, occurring in C. and S. Africa.

wide distribution (polychore distribution) Situation in which taxonomic groups of plants (and to a lesser extent animals) have a very extensive distributional range, spanning several floral kingdoms or regions, e.g. 'wides' may be cosmopolitan, subcosmopolitan, tropical, or temperate.

wig tree (*Cotinus coggygria*) *See Cotinus*.

wilderness Extensive area of land which has never been subject to intensive human use and is thus natural, or as nearly so as is possible, and which is set aside in perpetuity as an area from which humans, other than occasional visitors, are excluded. Areas are selected for the ecological wholeness, rather than for the presence of any particular biota, landscape, or recreational attraction. In the USA, where wilderness areas have been formally designated, no economic use is allowed except by presidential decree in extreme emergency. The areas are free from traffic, and the number and activities of visitors are carefully controlled. Elsewhere the concept merges with that of national parks, wilderness areas often being zones of more restricted public access within the park areas.

wildlife Any undomesticated organisms, although the term is sometimes restricted to wild animals, excluding plants.

wild oat (*Avena fatua*) *See* herbicide.

wild service tree (*Sorbus torminalis*) *See Sorbus*.

wild-type gene The allele most frequently observed at a given gene locus.

wilga (*Geijera parviflora*) *See Geijera*.

willemite Mineral, specific gravity 4.0, hardness 5.5, chemical composition Zn_2SiO_4, named after King William I of the Netherlands. It occurs mainly in the oxidized zones of zinc deposits. It is distinguished by its greenish colour and its strong fluorescence. Its basic colour is greenish-yellow, but it can vary to brown or white, and it has a vitreous lustre. It crystallizes in the trigonal system. The crystals can be prismatic, but it usually forms granular or massive aggregates.

willie wagtail (*Rhipidura leucophrys*) *See Rhipidura*.

willow *See Salix*.

willow moss Common name for the moss *Fontinalis antipyretica*. *See Fontinalis*.

willow peppermint (*Agonis flexuosa*) *See Agonis*.

willy-willy Local term for the intense tropical cyclones of W. Australia.

Wilson's petrel (*Oceanites oceanicus*) *See Oceanites*.

wilt Type of plant disease in which wilting (i.e. loss of plant turgidity) is a principal symptom. Wilts are frequently due to infection of the plant by a fungus belonging to the Deuteromycotina. *See*, for example, verticillium wilt.

wilting Limpness found when plant tissues contain insufficient water to hold the cells rigid. This may occur when the rate of transpiration exceeds the rate at which water is able to enter the root system from a soil containing ample water, causing temporary wilting from which the plant recovers when the transpiration rate falls. It may also be due to a deficiency of water in the soil. *See also* permanent wilting percentage.

wilting coefficient *See* permanent wilting percentage.

wilting point *See* permanent wilting percentage.

Windermere Interstadial (Late-Devensian Interstadial) Relatively warm period that occurred towards the end of the last (Devensian) glaciation in Britain. The event took place about 13 000–11 000 radiocarbon years BP. It includes the Bølling, Older *Dryas*, and Allerød chronozones of Scandinavia.

windmill palm (*Trachycarpus fortunei*) *See Trachycarpus*.

'windpipe' *See* trachea.

wind rose Quantitative diagram representing the relative frequencies of different wind directions and wind speeds at a climatic station over a period of time.

windrow Streak of foam or row of floating debris, aligned in the prevailing wind direction, formed on the surface of a lake or ocean. Where winds blow across a water surface vertical circulation cells are set up in near-surface waters. These circulation cells are alternately right- and left-handed vortices and windrows form along the lines of convergence between adjacent cells at the water surface.

windscorpions *See* Solifugae.

wind shear The gradient of horizontal wind velocity with height, which varies according to the rate of change of temperature with altitude. Vertical wind shear can be a cause of cloud formation in the turbulent mixing in a boundary layer of air moving at different speeds. The shear between the wind at different levels can be expressed as a vector, measuring the difference of speed and direction.

windward 'Upwind', i.e. in the direction from which the wind blows.

wing coupling The joining together of the two pairs of wings of many insects, so that effectively the forewing and hindwing operate as a single wing. *See also* frenulum; hamulus; and retinaculum.

wing covert Feather that covers the base of a main wing feather. On the upper side of the wing each remex is covered by a greater covert, which is covered by a median covert, and then the minor coverts. A similar arrangement occurs on the underside, although the feathers are usually less well developed.

wing nut *See Pterocarya*.

Winkler method The standard chemical procedure for measuring oxygen in water.

Winteraceae Family of trees and shrubs in which the leaves are simple, alternate, gland-dotted, and without stipules. The flowers have many free parts.

The wood is without vessels. Winteraceae are the southern hemisphere counterpart to the Magnoliaceae. There are seven genera, with 120 species, occurring from Borneo to the Pacific islands and Australasia, and also in S. America.

winter kill Heavy mortality among fish in lakes covered by ice and snow, due to lack of oxygen.

winter wren (*Troglodytes troglodytes*) *See Troglodytes*.

wireworm *See* Elateridae.

Wisconsin school A group of ecologists, led by J. T. Curtis and his associates, who developed a range of simple ordination methods in 1950 and later, while studying the vegetation of Wisconsin. In the most widely applied scheme, density–frequency–dominance (DFD) values are estimated for all species recorded in the field. Importance values derived from these enable identification of leading dominants. Stands with the same leading dominant are grouped together and importance values for all species recalculated within the groups. These values are used to assign climax adaptation numbers and subsequently a continuum index is derived. Later developments, notably by Bray and Curtis (1957) improved the way in which stand similarities were expressed and portrayed graphically, by using a similarity index calculated from stand data rather than using the subjectively assessed continuum index. *See also* coefficient of similarity.

witch eel *See* Nettastomidae.

witches' broom A dense, broom-like cluster of proliferating branches or twigs at a particular point in a tree or shrub; from a distance it may resemble a bird's nest. Witches' brooms may be caused by infection with any of a number of organisms, including certain rusts; *Taphrinia betulina* is a common cause of witches' brooms in birch trees (*Betula*).

witches' butter Common name for the fruit bodies of *Exidia* species of fungi, usually referring to *Exidia glandulosa*.

witch hazel (*Hamamelis virginiana*) *See* Hamamelidaceae.

Wiwaxia Early mollusc from the Mid Cambrian Burgess Shales of Canada, which is unique in that its body is covered in large scales and spines. It possessed a rasp-like feeding organ rather like the radula of a gastropod, and lived on the sea-floor, using the radula as a scraping device.

wobble hypothesis Theory proposed to explain the partial degeneracy of the genetic code in that some tRNA molecules can recognize more than one codon. It is proposed that the first two bases in the codon and anticodon will form complementary pairs in the normal antiparallel fashion. However, a degree of steric freedom or 'wobble' is allowed in the base pairing at the third position. Thus, for serine, six mRNA codons may be paired with only three tRNA anticodons.

wolf (*Canis lupus*) *See* Canidae.

Wolffia (family Lemnaceae) Genus of minute floating herbs, which have a tiny thallus with no roots or leaves. *W. arrhiza* is the smallest known flowering plant and is scarcely visible to the naked eye. There are 10 species, with a cosmopolitan distribution.

wolffish (*Anarhichas lupus*) *See* Anarhichadidae.

wolfherring (*Chirocentrus dorab*) *See* Chirocentridae.

wolframite Mineral, specific gravity 7.0–7.5, hardness 5.0–5.5, and with the chemical composition $(Fe,Mn)WO_4$. It occurs in high-temperature hydrothermal veins, quartz veins, and pegmatites, associated with granitic rocks. It is associated with cassiterite, arsenopyrite, tourmaline, scheelite, galena, sphalerite, and quartz. It is distinguished by its colour, good cleavage, and high specific gravity. It is grey-black to brownish-black, and has a brownish-black streak, and a metallic lustre. It has one perfect cleavage. It crystallizes in the monoclinic system. The crystals are normally tabular, prismatic, often bladed, and also granular and massive. It is an ore mineral for tungsten.

wolf spiders *See* Lycosidae.

wollastonite Mineral, specific gravity 2.8–3.1, hardness 4.5–5.0, chemical composition $CaSiO_3$, named after the British mineralogist W. H. Wollaston. It occurs in metamorphosed, silicaceous limestones, and also in alkaline, igneous rocks, and associated with calcite, epidote, and tremolite. It is distinguished by its colour, three cleavages, and its solubility in hydrochloric acid with the separation of silica. It is white to grey, and has a vitreous to pearly lustre. It crystallizes in the triclinic system. The crystals are tabular, prismatic, also massive, fibrous, or cleavage masses. It is used as a source mineral for rock wool of high strength and long fibres.

wolverine (carcajou, glutton, skunk bear, *Gulo gulo*) *See* Mustelidae.

wombat *See* Vombatidae.

wood 1 Area of trees, often associated with a particular name (e.g. Hayley Wood) that denotes a district area. 2 The produce of coppice or underwood that is not of timber size.

wood ant *See Formica rufa*.

wood blewit (*Lepista nuda*) *See* blewit.

woodchuck (marmot, *Marmota marmota*) *See* Sciuridae.

woodcreepers *See* Dendrocolaptidae; and *Xiphorhynchus*.

wood-eating cockroach (*Cryptocercus punctulatus*) *See* Cryptocercidae.

wooden tongue Disease of cattle caused by the actinomycete *Actinobacillus lignierisii*. Lesions develop in the tongue, leading to a stiffness or 'woodenness'.

wood-hoopoes (*Phoeniculus*) *See* Phoeniculidae.

woodland 1 Vegetation community that includes mature trees, which are usually spaced more widely and so are more spreading in form than forest trees.

Between the trees grass, heath, or scrub communities typically develop, giving a park-like landscape. 2 General term for a wooded landscape, often used generally, e.g. 'broad-leaved woodland', or to describe a number of separate wooded areas, e.g. 'The Estate Woodlands'. Colloquially, the terms 'forest' and 'woodland' are often used interchangeably in Britain.

woodlice (subclass Malacostraca, order Isopoda) Isopods which have a terrestrial habit and in which the uniramous first antennae are very small. *See also Porcellio scaber*; Porcellionidae; and *Platyarthrus hoffmannseggii* (ant woodlouse).

wood mouse (field mouse, *Apodemus sylvaticus*) *See* Muridae.

wood mushroom Common name for the fruit body of *Agaricus silvicola*. The fruit body resembles that of the cultivated mushroom but has an odour of aniseed. It is found on the ground in woods during late summer and autumn and is edible.

wood-pasture Land on which trees grow and where farm livestock or deer are grazed systematically. *See also* pollarding.

woodpeckers 1 *See Melanerpes*; Picidae; Piciformes; *Picoides*; and *Picus*. 2 (piculets) *See Picumnus*.

wood quails *See Odontophorus*.

Woodsia (family Aspleniaceae) Genus of small ferns, characterized by a short rhizome, very scaly frond under-sides, and orbicular sori on the under-sides of the leaves, with an indusium surrounding the base of the sorus, which is either split into hair-like segments from the beginning, or starts as a cup, splitting into hair-like segments later. There are 38 species, occurring in the arctic, and in northern temperate mountain regions.

wood sorrel (*Oxalis acetosella*) *See Oxalis*.

wood storks *See Ibis*.

wood-swallow *See* Artamidae.

wood-warbler *See Basileuterus*.

woodwasps *See* Orussidae; Siricidae; and Symphyta.

woodworm (*Anobium punctatum*) *See* Anobiidae.

woody pear *See Xylomelum*.

woolly bear 1 (*Anthrenus*) *See* Dermestidae. 2 *See* Arctiidae.

woolly rhinoceros (*Coelodonta*) *See* Rhinocerotidae.

woolsorter's disease Pulmonary anthrax. *See* anthrax.

worker In social insects, the caste that rears the brood, maintains the structure of the nest, and forages for food. Usually workers are sterile; female in ants, bees, and wasps, and either male or female in termites. In termites, a true worker caste (incapable of metamorphosis) occurs only in Termitidae. In the lower families colony labour is performed by nymphs and pseudergates.

worm eel *See* Moringuidae.

wormfish *See* Microdesmidae.

worm lizard *See* Amphisbaenidae.

worms *See* Annelida; and Platyhelminthes.

wormwood (*Artemisia absinthum*) *See Artemisia*.

wound response The metabolic activity that follows the disruption of plant structure by external forces, e.g. by wind or freezing. This activity is controlled by hormones in higher plants and typically includes an increased rate of synthesis of callose and gummy substances, the formation of more endoplasmic reticulum, and more mitotic divisions, followed by the differentiation of roots and buds.

wound-tumour virus RNA-containing, plant-infecting virus which can cause the formation of galls in a wide range of plants. The virus can be transmitted from plant to plant by leafhoppers.

wrack Common name for any seaweed of the family Fucaceae. *See also* bladder wrack; egg wrack; serrated wrack; and spiral wrack.

wrasse 1 *See* Labridae. 2 (cleaner wrasse, *Labroides dimidiatus*) *See* cleaner fish.

wrens 1 *See Troglodytes*; and Troglodytidae. 2 (Australian wrens) *See* Maluridae. 3 (marsh wrens) *See Cistothorus*. 4 (New Zealand wrens) *See* Xenicidae.

wren-thrush (*Zeledonia coronata*) *See* Zeledoniidae.

wren-tit (*Chamaea fasciata*) *See* Chamaeidae.

Wright's inbreeding coefficient *See* coefficient of inbreeding.

wrymouth *See* Cryptocanthodidae.

wrynecks *See Jynx*.

Wuchereria bancrofti *See* elephantiasis.

wulfenite Mineral, specific gravity 6.5–7.0, hardness 3.0, chemical composition $PbMoO_4$, which occurs as a secondary mineral in the oxidized zones of ore minerals of lead and molybdenum, and in association with anglesite, cerussite, and pyromorphite. It is distinguished by its orange-yellow colour and the square, tabular habit of its crystals. It can be orange-yellow, olive-green, or brown, and has a white streak, and a resinous lustre. It has a sub-conchoidal fracture. It crystallizes in the tetragonal system. The crystals are usually square plates or tablets, but sometimes massive, granular, or botryoidal.

Würm *See* Devensian.

X

Xanthidae (mud crabs; subclass Malacostraca, order Decapoda) Family of crabs several species of which have neurotoxins contained in their exoskeletons. Mud crabs are oval to hexagonal, and broadened anteriorly. Many are very fecund, *Menippe mercenaria* (stone crab) producing 3–6 million eggs in less than 70 days. This species can be a serious predator of oysters, each crab taking on average up to 219 small and large oysters per year. Some species of mud crabs live on coral reefs, and three or four species of *Xantho* occur in European waters.

Xanthomonas (family Pseudomonadaceae) Genus of bacteria in which cells are straight rods each with a single polar flagellum. They are aerobic chemoorganotrophs. All species are plant pathogens, causing various types of diseases in a wide range of plants.

Xanthophyceae (yellow-green algae) Class of algae in which the chloroplasts are yellow-green and which form motile cells with one forward-directed tinsel flagellum and one backward-directed whiplash flagellum. These cells typically function as motile spores (zoospores). 'Mature' organisms may be unicellular, colonial, filamentous, or multinucleate and coenocytic (siphonaceous). Immotile unicellular forms can usually convert readily to the flagellated motile form. There are five orders, found mainly in freshwater habitats.

xanthophyll Group of compounds that are oxygenated derivatives of carotenes, which act as accessory pigments during photosynthesis in plants.

Xanthophyllum (family Polygalaceae) Genus of rainforest trees whose leaves often dry yellowish. The flowers are pentamerous, usually with one hood-like petal. The fruit is indehiscent, woody or somewhat fleshy, containing one seed or many. The trees yield useful timber. There are 60 species, occurring from India and Hainan to the Solomon Islands.

Xanthoria (family Teloschistaceae) Genus of lichens in which the thallus is foliose, usually bright yellow or orange in colour, and is attached to the substrate by rhizines on the lower surface. *X. parietina* is perhaps the best known of all lichens; its bright yellow rosette-like thalli, each bearing crowded apothecia in the centre, are a familiar sight on farm buildings, on rocks by the sea, etc. This species is moderately tolerant of air pollution.

Xanthorrhoea (family Xanthorrhoeaceae) Genus of grass-trees, which are woody, perennial plants with narrow, sheathing, and linear leaves, and dry, papery flowers. The outer parts of the flower are like glumes, and thicker than the inner parts which are membranaceous and dry. The plants are often very tall, and are found in dry, open habitats and in *Eucalyptus* woodland, often on soils of low fertility. *X. hastilis* (black-boy) is found in the Australian bush, where it forms a tussock with a long, bulrush-like spike of flowers. It yields a resin from the leaf bases which is used in varnish and sealing wax. There are 15 species, found only in Australia.

Xanthorrhoeaceae (grass-trees) Family of monocotyledonous, stout, woody, perennial plants with rhizomes, which are often xerophytic. They are tall, with few branches, and simple, linear, sheathing leaves. The regular flowers are bisexual or unisexual, on dioecious plants, and are held in panicles, spikes, or clusters. The perianth comprises two whorls of three segments, and is usually dry and papery. There are two whorls of three stamens, the inner whorl usually attached to the flower segments. The superior ovary is of three fused carpels, with three locules containing one or more ovules. The fruit is a capsule, or single-seeded nut. The plants are often components of dry, open *Eucalyptus* scrub or woodland. There are eight genera, with 66 species, of which seven genera are endemic to Australia. The remaining genus is found in Malaysia and New Zealand.

Xanthorrhoea hastilis (black-boy) *See Xanthorrhoea.*

Xanthosoma (family Araceae) Genus of plants several species of which are cultivated for their starchy, edible, lateral tubers, known as tannia or yautia. There are 45 species, occurring in the W. Indies, and in C. and S. America.

Xantusiidae (night lizards; order Squamata, suborder Sauria (Lacertilia)) Family of nocturnal, insectivorous lizards in which the eye is gecko-like, with a vertical pupil and spectacle. Some species are viviparous with a placental-type development. There are 12 species, occurring in C. America and the SW USA.

X-chromosome The sex chromosome found in double dose in the homogametic sex and in single dose in the heterogametic sex. Unlike the Y-chromosome, it contains numerous genes (which therefore show sex-linkage).

Xenarthra (cohort Unguiculata, order Edentata) Suborder comprising the infra-orders Cingulata and Pilosa, the S. American edentates known since the Eocene, and characterized by additional articulations in the lumbar vertebrae (the name of the suborder means 'extra jointed'), the union of the ischium and the caudal vertebrae, and a distinctive skull structure. The claws are well developed: in the arboreal sloths they are used for hanging below the branches of trees; in other families they are used for digging, and oblige the animals to walk on the sides of their feet. The infra-orders distinguish

between the forms with hair (the ant-eaters and sloths) and those with 'shells' (the armadillos).

xenia Situation in which the genotype of the pollen influences the developing embryo or the maternal tissue (endosperm) of the fruit to produce an observable effect on the seed. For example, a variety of maize with white endosperm may be pollinated by one possessing dark yellow endosperm to give seeds with pale yellow endosperm.

Xenicidae (New Zealand wrens; order Passeriformes) Family of small birds which are green or olive-brown above, grey or white below, with white supercilia. They have straight, slender bills, short wings, and very short tails. Their legs and toes are long, and the third and fourth toes are joined basally. They inhabit forests and scrub, feed on insects and spiders, and nest in rock or tree cavities. There are two genera, with three species, found in New Zealand. A fourth species, *Xenicus lyalli* (Stephen Island wren) became extinct in 1894.

Xenicus lyalli (Stephen Island wren) *See* Xenicidae.

Xenocongridae (false moray; class Osteichthyes, subclass Actinopterygii, order Anguilliformes) Small family of marine eels, which have a very elongate, slender, and scaleless body; small, round, gill openings; widely separated front and rear nostrils; and small pectorals, the pelvics being rudimentary or absent. The larvae of *Xenoconger fryeri* (45 cm) are reputed to be fairly common in the Mediterranean. There are about 15 species found in warm to tropical seas.

xenolith Inclusion or enclave of a pre-existing rock in an igneous rock. Xenoliths are often derived from the country rocks that have been invaded by the igneous mass and frequently they show some reaction, e.g. rounding of their edges and metamorphism.

Xenopeltidae (sunbeam snakes; order Squamata, suborder Serpentes (Ophidia)) Monotypic family comprising *Xenopeltis unicolor* (sunbeam snake), a burrowing snake, characterized by its iridescent brown scales. It preys on small vertebrates, including other snakes. It occurs in SE Asia.

Xenopterygii Alternative name for fish belonging to the order Gobiesociformes.

Xenopus laevis (clawed frog, clawed toad; order Anura (Salientia), family Pipidae) A totally aquatic anuran in which the three inner toes of the large, webbed hind feet have black, horny, claw-like sheaths. Females grow up to 13 cm long, males are smaller. Food, which includes fish, carrion, and invertebrates, is pushed into the mouth with the forefingers. *X. laevis* occurs in tropical and southern Africa.

Xenosauridae (xenosaurs, crocodile lizards; order Squamata, suborder Sauria (Lacertilia)) Family of robust lizards which enter water readily. They have a mixture of large and small scales. The family comprises the xenosaurs, three species of crepuscular insect-eaters from the rain forests of C. America, and a single species from China, *Shinisaurus crocodilurus* (crocodile lizard) which feeds on fish.

xenotime Accessory mineral, specific gravity 4.4–5.1, hardness 4.0–5.0, chemical composition YPO_4. It is found in granitic and alkaline, igneous rocks, as well as in pegmatites and gneisses. It is distinguished from zircon by being softer and having cleavage. It can be yellowish-brown, greyish-white, or pale yellow; and has a pale brown streak, and a resinous to vitreous lustre. It crystallizes in the tetragonal system. Its crystals are tetragonal prisms, very similar to zircon.

xeric Dry, as opposed to wet (hydric) or intermediate (mesic), environment.

xeromorphic (zeromorphic) Applied to organisms that show morphological adaptations that enable them to withstand drought.

xerophile (zerophile) Plant of warm, dry desert environments in A. P. A. de Candolle's (1874) classic temperature-based scheme of world vegetation zones. *Compare* megatherm.

xerophyte (zerophyte) Plant that can grow in very dry conditions and is able to withstand periods of drought. The adaptations include an ability to store water, waxy leaves and leaves reduced to spines to avoid water loss through transpiration, and short life cycles that can be completed when sufficient water is available.

xerosere The characteristic sequence of communities reflecting the developmental stages of a plant succession that begins in an arid environment. *See also* succession.

Xestobium rufovillosum (death-watch beetle) *See* Anobiidae.

Xiphiidae (swordfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine fish including only the species *Xiphias gladius*. Distinguished by a long, slightly flattened snout ('sword'), this large fish can reach a length of 4.8 m. The pectoral fins are placed low on the body, opposite the large, but short-based, dorsal fin; the pelvic fins are absent. Like the related marlins (family Istiophoridae), the swordfish has a large, lunate (half-moon shaped) tail-fin, and it can swim very fast. Popular as a big game fish, it is also caught by longline set by commercial fishing vessels. It is distributed worldwide in warmer seas.

Xiphodontidae Primitive Eocene and Oligocene artiodactyls, restricted to Europe, and representing a European parallel to the camels which were evolving in the New World at the same time. Probably both groups were descended from early anoplothere stock. In some respects the anoplotheres represent the most primitive ruminants known.

Xiphophorus helleri (green swordtail) *See* Poeciliidae.

Xiphorhynchus (woodcreepers; family Dendrocolaptidae) Genus of birds, which have chestnut-brown plumage, with pale streaks on the head,

under-side, and upper back. The bill is long and slightly decurved. The tail is fairly long, with stiff feather-tips for support. Woodcreepers are strictly arboreal, and feed on insects sought by spiralling up a tree trunk. They nest mainly in tree cavities. There are 14 species, found in C. and S. America.

X-ray fluorescence The secondary X-ray emission that results when electrons from the outer orbitals of an atom fill vacant inner orbital positions originally created by X- or gamma-ray excitation. These X-rays are characteristic of excited atoms.

X-ray fluorescence spectrometry An analytical method which can be used to determine the concentration of a wide range of chemical elements, using the intensity of their fluorescent X-rays.

Xyelidae (suborder Symphyta, superfamily Xyeloidea) Uncommon, primitive, symphytan family, whose members are generally less than 5 mm long. Adults are brownish, with a very long third antennal segment, and feed on pollen from catkins of birch and other trees. The larvae are maggot-like, with short legs. Those of some species develop within pine cones, but others are external feeders on elm and hickory.

xylan Polysaccharide containing xylose, commonly found in the cell walls of higher plants. The molecules consist of a backbone of beta-xylose units linked between the first and fourth carbon atom of neighbouring sugar units, with side chains of various degrees of complexity and containing a variety of other sugars. *See also* hemicellulose.

Xylaria (family Xylariaceae) Genus of wood-rotting fungi. *X. hypoxylon* forms branching, antler-like fruit bodies (stromata), the upper parts of which are white with powdery conidia. Perithecia are formed on the lower parts of the stromata. *X. polymorpha* forms clusters of finger-like stromata on old tree stumps.

Xylariaceae (order Sphaeriales) Family of fungi in which perithecia occur embedded in stromata. Asci are persistent, ascospores black and single-celled. There are many genera. Chiefly saprotrophic, they are found on wood and other substrates. A few are parasitic on higher plants.

xylem Plant tissue consisting of various types of cells, which transports water and dissolved substances toward the leaves. It can be distinguished from the phloem by the presence of vertical systems of dead cells with thick, lignified walls.

Xylocarpus (family Meliaceae) Genus of mangrove forest trees which have big, spreading buttresses. The fruit is a large, spherical capsule. The seed has a corky testa, adapted thereby to water dispersal. The trees yield a valuable cabinet timber. There are two species, occurring in the Old World tropics.

Xylocopa (Old World carpenter bees) *See* acarinum; and Anthophoridae.

Xylomelum (woody pear; family Proteaceae) Genus of small trees which have leathery, opposite leaves. The flowers are white, yellow, or brown, held in axillary spikes, and are tubular at first, then splitting to allow the style to protrude, and later the stigma, leaving four segments to which a single anther on a short filament is attached. The stigma is club-shaped. The fruits are the size and shape of pears, but with a wall of woody tissue enclosing the winged seeds. There are four species, all endemic to Australia.

xylophagous Wood-eating.

xylophilous Preferring to grow on wood.

Xyridaceae Family of monocotyledonous, herbaceous plants, which are mostly perennial. They are rush-like marsh plants with radical, sheathing leaves, and dense spikes or heads of flowers. The leaves are linear and cylindrical, or with narrow, flat blades. The flowers are bisexual and held in the axil of a stiff bract. The inner of the three sepals forms a hood over the petals, while the others are keeled. The corolla is a tube with three lobes, and is usually yellow in colour. The stamens are held opposite the corolla lobes and are attached to the tube. The ovary is superior, with the three carpels fused to form a single locule with many ovules, and a three-lobed style. The corolla remains on the seed capsule. There are two genera, with about 250 species, distributed throughout tropical and subtropical regions, but centred in America.

Y

yak (*Bos grunniens*) *See* Bovidae.

yam 1 Tubers of about ten cultivated species of *Dioscorea*, most of which are tropical, but two of which (*D. opposita* and *D. japonica*) are cultivated in temperate regions in Asia. 2 In the USA the name is also applied to the sweet potato (*Ipomoea batatas*), a somewhat similar but unrelated edible tuber. 3 The yam bean is a name given to the seed of several species of Leguminosae (e.g. *Pachyrhizus erosus* and *Sphenostylis stenocarpa*) which also produce edible tubers.

yardang Streamlined, wind-sculptured hill ranging in length from metres to kilometres and developed in any bedrock that is at least weakly consolidated. Yardangs are restricted to deserts that have high aridity with minimal plant cover and soil development, and that are dominated by strong, unidirectional winds for most of the year.

yautia *See Xanthosoma*.

yaws Tropical disease of humans caused by *Treponema pertenue*. Symptoms begin with ulcerative lesions on skin and mucous membranes; later, bone lesions develop.

Y-chromosome The sex chromosome found only in the heterogametic sex. It usually differs in size from the X-chromosome and contains few or no major genes. Often only a short part of it pairs with the X-chromosome at meiosis.

yeast General term for a fungus that can exist in the form of single cells, reproducing by fission or by budding. Sometimes the name refers more specifically to *Saccharomyces cerevisiae*.

yellow-banded butterflyfish (*Nemipterus hexodon*) *See* Nemipteridae.

yellow chub (*Kyphosus incisor*) *See* Kyphosidae.

yellow fever Acute disease affecting humans and other primates; it occurs for example in C. and S. America. Symptoms include jaundice, fever, vomiting, and haemorrhages; the disease is often fatal. It is caused by a virus of the Togaviridae, and transmitted by mosquitoes.

yellow-fever mosquito *See Aëdes aegypti*.

yellowfin perchlet (*Ambassis elongatus*) *See* Centropomidae.

yellow-green algae *See* Xanthophyceae.

yellow gurnard (*Trigla lucerna*) *See* Triglidae.

yellowjacket (superfamily Vespoidea, family Vespidae) The common name often applied to any of the black and yellow wasp species of the family Vespidae, but sometimes restricted to *Vespa crabro* (hornet).

yellows General term for any plant disease in which yellowing or chlorosis is a characteristic symptom. Yellows diseases are often caused by viruses but may be caused by bacteria or fungi.

yellowthroats *See Geothlypis*.

yellow wagtail (*Motacilla flava*) *See Motacilla*.

yerba maté *See Ilex*.

Yersinia (family Enterobacteriaceae) Genus of Gram-negative bacteria in which the cells are ovoid or rod-shaped, and motile or non-motile. They occur as parasites and pathogens of humans and other animals. *Y. pestis* (formerly called *Pasteurella pestis*) is the causal agent of plague.

ylang ylang (macassar oil) *See Cananga*.

Yoda's power law Numerical description of the process of self-thinning among plant seedlings. Beyond a certain density of sowing, the number of surviving plants is not related to the initial seed density; instead a constant relationship is evident between the density of survivors and their total biomass. K. Yoda *et al.* (1963) summarized this relationship as $W = C\rho^{-3/2}$ where W is the dry weight of surviving plants, ρ is the density of the surviving plants, and C is a constant reflecting the growth characteristic of the species concerned.

yolk Material consisting of a mixture of lipids and proteins, secreted in the form of granules, that in eggs acts as a source of food for the growth and development of an embryo.

yolk body (yolk platelet) Membrane-bound storage structure containing protein and lipid that is found in large numbers in the cytoplasm of the eggs of all animals except marsupial and placental mammals.

yolk platelet *See* yolk body.

yolk sac In the embryos of vertebrates, a sac arising as a diverticulum of the alimentary canal with which, except in teleosts, it communicates. In reptiles, birds, and monotremes it contains yolk which nourishes the embryo, and as the yolk is consumed the sac merges with the embryo. In marsupials the sac contains no yolk, but absorbs nutrient from the uterine wall and in some cases forms a temporary placenta. In eutherians the sac contains no yolk and most of it is cut off from the embryo at birth.

yom hin *See Chukrasia*.

Z

zalambdodont Applied to molar teeth that are V-shaped, narrow at the front and rear, with a sharp apex, and with the two cusps partly or completely fused.

Zamiaceae Family of gymnosperms which forms the bulk of the cycads. The pinnules are straight in vernation and the male and female spirophylls are in determinate cones, the female being scale-like with a thickened base, usually with two ovules. There are eight genera, with 80 species, distributed in tropical and temperate Australia, America, and Africa. Two genera are endemic to Australia.

Zannichelliaceae Family of submerged, perennial, aquatic, monocotyledonous herbs of fresh or salt water, comprising plants that have slender, creeping rhizomes, and stems bearing narrow, linear, opposite, whorled, or alternate leaves, with sheathing bases, and tiny flowers, solitary in leaf axils or in small clusters. The flowers are unisexual. There is either no perianth, or one composed of three tiny scales. Male flowers have 1–3 stamens, with one or two anther cells, while in female flowers up to nine carpels are free from each other and terminate in a long beak bearing the stigma. Pollination occurs under water, and the fruits are achenes. There are six genera, with some 20 species, of very wide distribution.

Zantedeschia (family Araceae) Genus of eight species of tropical African plants, which includes *Z. aethiopica*, the florist's arum lily.

Zapodidae (jumping mice; order Rodentia, suborder Myomorpha) Family of mouse-like rodents in which the hind limbs are more or less elongated, permitting saltatorial movement, and the tail is long and used for balancing. The cheek teeth are either brachydont or semihypsodont. Cheek pouches are present. They are distributed widely throughout the temperate northern hemisphere. There are four genera, with 11 species.

zapote *See Manilkara*.

Zaproridae (prowfish; class Osteichthyes, subclass Actinopterygii, order Perciformes) Monospecific family of marine, bottom-dwelling fish living at depths of 100–500 m, although the juveniles have been found associated with planktonic jellyfish. *Zaprora silenus* (88 cm) has a stout, compressed body with a blunt head, a very long, low, dorsal fin, rounded pectoral and tail fins, but no pelvic fins. It is found only in the colder waters of the N. Pacific.

Z-chromosome The sex chromosome found in both heterogametic females and homogametic males.

zebra (family Equidae) Horse with a distinctive coat patterned in light and dark stripes. There are several species, all included in the genus *Equus* and all confined to Africa, the best known being *E. burchelli* (Burchell's zebra or bontequagga).

zebra danio (*Brachydania rerio*) *See* Cyprinidae.

zebu cattle *See* Bovidae.

Zechstein Name given to a shallow gulf sea or depositional sequence of rocks. The sea occurred in a shallow gulf area over N. Germany and the North Sea Basin. The depositional sequence laid down in this sea consisted of carbonates and evaporites. These are of Upper Permian Age.

Zeidae (dories; class Osteichthyes, subclass Actinopterygii, order Zeiformes) Family of marine fish which have a deep and compressed body, a large head with a wide and protrusible mouth slanted upward, and large eyes. The two sections of the dorsal fin are separated by a distinct notch. In several European countries *Zeus faber* (John Dory), 66 cm, is also known as St Peter's fish, because of the presence of a black spot ('thumbprint of St Peter') on the sides of the fish. Dories are netted commercially and are often rated highly as a table fish. There are several species, distributed in the Atlantic and Pacific. *See also* protrusible mouth.

Zeiformes Order of bony fish with deep, strongly compressed bodies; narrow caudal peduncles; large, protrusible mouths; and large eyes. They are found in inshore and offshore habitats. The largest and best-known family in the order are the Zeidae (dories).

Zeledonia coronata (wren-thrush) *See* Zeledoniidae.

Zeledoniidae (wren-thrush; order Passeriformes) Monotypic family which comprises *Zeledonia coronata*, a small, dark brown and slate bird with an orange crown. It has a short, pointed bill, short and rounded wings and tail, and long legs. It inhabits forests; feeds on insects; and builds a domed nest, with a side entrance, on a bank. It is found in C. America, and is sometimes included with the Turdidae.

Zelkova (family Ulmaceae) Genus of deciduous trees and shrubs, which have smooth bark. The leaves are spiral and toothed. The fruit is a nut. They yield good cabinet wood. There are six or seven species occurring in warm-temperate Asia.

zeolite Member of a group of hydrated aluminosilicates of sodium, potassium, calcium, and barium, which occur in geodes, altered igneous rocks, and some sediments. The water molecules are weakly held and the hydration–dehydration reaction has some useful applications, as do the ion-exchange properties of zeolites.

zephyr Prevailing light and warming breeze from the west at the time of the summer solstice (in the northern hemisphere).

xeromorphic *See* xeromorphic.

xerophile *See* xerophile.

xerophyte *See* xerophyte.

zeugen Mushroom-shaped rock that has been eroded by the abrasive action of wind-blown sand. The undercutting effect is concentrated near ground level, where sand movement is greatest, and is enhanced in areas of near-horizontal strata when the lowest bed is relatively weak.

Zeugloptera *See* Lepidoptera.

Zeus faber (John Dory, St Peter's fish) *See* Zeidae.

Zieria (family Rutaceae) Genus of shrubs or small trees which have trifoliate and opposite leaves. The foliage is strongly aromatic when crushed due to the oil glands in the leaf. The flowers are solitary and axillary, white, pink, or mauve. The calyx is formed of four or five sepals, usually united at the base; the corolla is of four or five spreading petals, and is star-like. There are four stamens. The fruit is composed of four separate carpels, each with a single seed. Several species are cultivated as ornamentals. There are about 20 species, all endemic to Australia, and found in the south and east.

zinc (Zn) An element required by plants. It is found bound to a variety of enzymes, stabilizing them and also being involved in catalysis. Deficiency in plants prevents the expansion of leaves and internodes, giving a rosette-style of plant.

zinc blende *See* sphalerite.

Zingiberaceae (ginger, cardamon, turmeric) The ginger family, comprising rhizomatous herbs, many of which are huge, and spicy in all their parts. The leaves have pinnate nervation and a sheathing base with a two-ranked ligule. The aerial stems are oblique, but in *Costus* and its allies spiral. Inflorescences are borne either on leafy stems or separately from the rhizome. There are 49 genera, with 1300 species, occurring, mostly in rain forest, throughout the tropics but chiefly in Indo-Malaysia.

zinnwaldite Mineral, specific gravity 2.9–3.2, hardness 2.0–3.0, and with the chemical composition $(K,Li,Fe)Al(Si_3AlO_{10})(F,OH)_2$, named after Zinnwald, Saxony, W. Germany. It occurs in similar circumstances as lepidolite in gneisses, granites, and pegmatites, in association with wolframite, scheelite, cassiterite, fluorite, and topaz. It is a micaceous mineral which is grey, brown, or even dark green, and has a vitreous to pearly lustre. It crystallizes in the monoclinic system. It forms thick, tabular crystals with a well-marked cleavage.

Ziphiidae (bottle-nosed and beaked whales; order Cetacea, suborder Odontoceti) Family of whales, in which the snout is long and narrow, in some species with a high, bulging forehead; the dorsal fin and flippers are small; and the tail is only slightly notched at the midline. The first two cervical vertebrae are fused, and in *Hyperoodon* (bottle-nosed whale) all the cervical vertebrae are fused. The number of teeth is variable, from one or two pairs in the lower jaw only, to 38 in the upper and 54 in the lower jaw. Ziphiids attain lengths of 4–12 m and are found in all oceans. They dive to considerable depths and feed mainly on deep-sea fish and squid. There are five genera, with 18 species.

zircon Mineral, specific gravity 4.6, hardness 7.5, chemical composition $ZrSiO_4$, whose name is probably derived from the Arabic *zargon* (the same root as 'jargon', one variety of zircon) and which means 'golden colour'. It is one of the most widely distributed accessory minerals in igneous rocks (e.g. granite, syenite, pegmatites), when the crystals can be quite large. It also occurs in metamorphic rocks (e.g. gneisses and schists), and is found concentrated in detrital beach and river sands. It is the main source of zirconium metal. It is distinguished by its square, prismatic shape, brown colour, high hardness, and high specific gravity. Its most common colour is light brown or reddish-brown, but it can be grey, yellow, or green, and it has a vitreous lustre. It crystallizes in the tetragonal system. The crystals are usually square prisms with bipyramidal terminations. Common zircon is used extensively in the foundry industry.

Zizyphus (family Rhamnaceae) Genus of small trees in which the stipules are often modified as thorns. The leaves have three main nerves. The flowers are pentamerous. The fruit is a drupe, edible in many species (jujube is *Z. jujuba*, occurring from India to S. China; *Z. lotus* is believed to be the lotus fruit of ancient times). There are 100 species, occurring in the tropics and subtropics.

Z-line In striated muscle, one of the regularly-spaced lines that bisect the I-bands and divide the myofibrils into sarcomeres.

Zn *See* zinc.

Zoantharia (class Anthozoa) Subclass of solitary and colonial anthozoans, with or without a calcareous exoskeleton, characterized by paired mesenteries being first developed in a cycle of six; insertion of new pairs in two (ventrolateral), four (lateral and ventrolateral), or all six primary exocoeles. Zoantharia first appeared in the Ordovician.

Zoanthiniaria (subclass Zoantharia) Order of solitary or, more commonly, colonial sea-anemones, which have one groove on the stomodaeum. Mesenteries are inserted only in ventrolateral exocoeles. Tentacles are unbranched. The body is usually encrusted with calcareous foreign bodies. Zoanthiniaria are most abundant in warm, shallow waters. There are two families, with six genera.

Zoarces viviparus (eelpout) *See* Zoarcidae.

Zoarcidae (eelpout; class Osteichthyes, subclass Actinopterygii, order Gadiformes) Family of marine fish which have an elongate and slender body, a relatively large head, and a slimy skin with small scales. The dorsal and anal fins are confluent with the tail-fin; the rudimentary pelvics are just in front of the rounded pectorals. All are bottom-dwelling species, but while *Zoarces viviparus*

(eelpout), 46 cm, is common in shallow coastal waters, *Melanostigma pammelas* (Pacific softpout), 10.2 cm, has been found at depths greater than 500 m. Although *Z. viviparus* is a live-bearing species, others, e.g. *Macrozoarces americanus* (ocean pout), are egg-layers. Caught in traps and trawl nets, pouts are sold as food fish, bait, or food for trout farms. There are at least 65 species, found in the temperate to cold waters of the arctic and antarctic.

zodiacal light Zone of light apparent at night, after twilight, and again before morning twilight, caused by atmospheric particles scattering sunlight.

zoea Larval stage in higher malacostracan Crustacea, characterized by the appearance of eight pairs of trunk appendages free of the carapace.

zonal Term used to describe winds in a mainly west-to-east or east-to-west direction, particularly in describing the main, broad airstreams of the general or large-scale atmospheric circulation, e.g. the zonal westerly winds of middle latitudes. The zonal index is a conventional measurement indicating the strength of the west-to-east airflow over middle latitudes, e.g. in latitudes 35–55° N. Strong westerlies with the pressure systems also in a west-to-east orientation accompany high values of the zonal index. Cellular or meridional airflow (or sometimes weak and chaotic patterns of circulation) accompany low values of the zonal index.

zonal scheme Scheme concerned with the use of numerous fossils as stratigraphic indicators for the subdivision of a sequence of rocks.

zona pellucida The transparent covering of an oocyte.

zonation 1 (geol.) The subdivision of a stratigraphic unit or units by means of fossils. 2 (of vegetation) The broad distribution of vegetation of the world according to latitude and altitude. The control is primarily climatic, and similar vegetation zones are encountered on the flanks of high tropical mountains to those found at sea-level between the tropics and the poles.

zone Term used to describe a unit of rock characterized by a clearly defined fossil content.

zone of aeration *See* vadose zone.

zone of saturation *See* phreatic zone.

zonula occludens *See* tight junction.

zonule Subdivision of a subzone based essentially on the presence of a given species. Several zonules are, for example, recognized in the Upper Cambrian Franconia Sandstone of Minnesota. Here the zone was recognized by the presence of the trilobites *Ptychaspis* and *Prosaukia*, the subzone by *Prosaukia*, and zonules by *P. striata* and *P. granulosa*.

zonure, Lord Derby's *See Cordylus giganteus*.

zoocoenosis *See* biocoenosis.

zooecium In Bryozoa, the body wall.

zoogeographical region *See* faunal region; and zoogeographical zone.

zoogeographical zone Geographical unit, distinguished by a fauna which is more or less distinctive at the species, genus, family, or order level, by virtue of its habitat, or past or present isolation.

zoogeography The study of the geographical distribution of animals at different taxonomic levels, particularly of mammals from order to species level. Emphasis is given to the explanation of distinctive patterns in terms of past and/or present factors, particularly migration routes.

Zoogloea (family Pseudomonadaceae) Genus of bacteria in which young cells are motile with a single polar flagellum, but later clump together to form flocs which may be visible to the naked eye. They are aerobic chemo-organotrophs, found in natural waters and in sewage-treatment plants.

zooid In colonial invertebrates, an individual member of a colony.

Zoomastigophorea (superclass Mastigophora) A class of animal-like protozoa which bear one or more flagella. Some members can also form pseudopodia. No species contains chloroplasts. There are nine orders, and many families, found in a wide range of habitats.

Zoonavena *See Chaetura*.

zooneuston Those animals associated with the surface of water, mainly in freshwater habitats, and influenced by surface tension. The group is divided into those associated with the upper surface of the film, to which the term 'epineustic' is applied, and those associated with the lower surface, described as 'hyponeustic'. Many organisms show adaptation to this environment—e.g. some Hemiptera have pads at the ends of their legs that enable them to walk across the water surface. *See also* neuston.

zoonosis Disease which can be transmitted from animals to humans.

zooplankton *See* plankton.

zoosporangium Sporangium within which are formed motile spores (zoospores).

zoospore Motile (flagellated) cell.

Zoothera (thrushes; family Turdidae) Genus of thrushes which have grey, brown, black, and orange plumage, some with spotted under-parts or wing bars, and many with a distinctive, white, under-wing stripe. They inhabit forests, feed on the ground on invertebrates and fruit, and nest in trees and bushes. There are 29 species, found in Africa, Asia, Indonesia, and N. and C. America.

Zoraptera (class Insecta) Order of small (less than 3 mm long), exopterygote insects which superficially resemble termites and are gregarious, although they appear to lack true social organization. They live under bark, and in association with plant debris, and feed on fungal spores and small arthropods, probably dead ones. Adults may be winged and pigmented, with eyes and ocelli; or non-pigmented, wingless, and blind. There is one

genus, with 22 described species, occurring in the Ethiopian, Oriental, Nearctic, Neotropical, and Pacific regions.

zorro (S. American dogs and foxes, *Atelocynus microtis*, *Urocyon*, *Cerdocyon thous*, *Speothos venaticus*) *See* Canidae.

Zosteraceae Family of perennial, submerged, marine, monocotyledonous herbs, with creeping or tuberous rhizomes, flattened stems, linear sheathing leaves, and the unisexual flowers in vertical rows, borne within a leaf sheath on one side of the flattened stem. There is no perianth. Male flowers each consist of a single stamen with thread-like pollen grains. Female flowers consist of an ovary with two stigmas. Pollination occurs in the sea. Modern classifications recognize two genera, with some 13 species, found in most temperate seas.

Zosteropidae (white-eyes; order Passeriformes) Family of small birds which have green upper-parts, yellow or white under-parts, and a distinctive, white eye ring. Their bills are slender, pointed, and slightly curved, and their tongues have frilled tips. Their wings are medium-length and pointed, and their tails medium-length and square. They inhabit forests and brush; feed on insects, fruit, and nectar; and nest in trees and bushes. There are 11 genera, with about 84 species, found in Africa, S. and SE Asia, Australasia, and the Pacific islands.

Zosterops (white-eyes; family Zosteropidae) Genus of white-eyes which have greenish backs, and most of which have yellow throats and yellow or white under-parts. Some have a chestnut flank stripe, and most have white orbital rings. They show a great diversity, with many endemic island species. They inhabit forests and bushes, and are gregarious; they feed on insects, fruit, and nectar, and build semipendent nests in trees and bushes. There are 63 species, found in Africa, from S. Asia to Australia, in New Zealand, and on many Pacific islands.

Zurich–Montpellier school of phytosociology (Montpellier school of phytosociology) A group led by J. Braun-Blanquet and his associates who developed a set of floristic methods for vegetation classification (in 1927 and later) at Zurich and Montpellier. These have been widely adopted in Europe although they are less accepted elsewhere. The aim was to provide a framework for the classification of the vegetation of the world, but in practice the scheme is most useful in regional and national surveys. The approach depends on detailed field surveying to identify vegetation associations which can then be grouped hierarchically into alliances, orders, classes, etc., with the vegetation circle (global scale) being the most complex hierarchical level. Suffixes added to the genitive stem of the generic names of the plants label the communities so identified and indicate the hierarchical status of the community:

Rank	Ending
class	-etea
order	-etalia
alliance	-ion
association	-etum
sub-association	-etosum
variant	(specific name used)

An extensive ecological literature discusses the system and introduces many modifications. The most often quoted objections relate to the use only of homogeneous stands in the description of vegetation; the concept of minimal area as it is used to define homogeneity; and in particular to the use of fidelity, and the associated problem of defining faithful species in order to characterize the associations. *Compare* Uppsala school.

zwitterion Dipolar ion (i.e. one with both negative and positive charges and therefore no net charge). Amino acids in solution at neutral pH usually exist in this form, when the amino group is protonated ($-NH_3^+$) and the carbonyl group dissociated ($-COO^-$).

Zygaenidae (burnets, foresters; order Lepidoptera) Family of small moths, which are generally brightly coloured, slow-flying, and diurnal. A vein Cu P is present in both forewings and hindwings. Many species are distasteful, some are toxic. The larvae have short, dense, secondary setae. The cocoon is above ground, tough, and elongate. The family is widespread. *See also* venation.

Zygnematales (class Chlorophyceae) Order of green algae characterized by the occurrence of isogamous sexual reproduction involving non-flagellated gametes. Fusion of the gametes may occur outside the parent cells, or may follow the transfer of a gamete from one parent cell to the other via a conjugation tube formed between them. There are three families, all found in freshwater habitats.

zygodactylous In birds, applied to feet having two toes pointing forwards, and two behind. The condition is found, for example, in Cuculidae, Picidae, Psittacidae, and Ramphastidae.

zygoma *See* zygomatic arch.

zygomatic arch (zygoma) Bone at the side of the skull which forms an arch from beneath the orbit to a position toward the back of the head. It is composed of the maxilla, jugal, and squamosal bones, but may be incomplete. The main chewing (masseter) muscle is attached to the zygomatic arch.

zygomorphic (irregular) Bilaterally symmetrical, as a snapdragon flower, and therefore divisible into equal halves in only one plane.

Zygomycetes (subdivision Zygomyotina) Class of fungi in which the vegetative stage typically is a well-developed, branched, coenocytic mycelium. There are three orders, found as saprotrophs or as parasites on other fungi, plants, or invertebrates.

Zygomycotina (division Eumycota) Subdivision of fungi characterized by the formation of non-motile asexual spores (aplanospores). Sexual reproduction involves the fusion of gametangia followed by zygospore formation. There are two classes. The subdivision includes saprotrophic and parasitic species.

zygophore In fungi of the Mucorales, a specialized hypha which bears a zygospore.

zygospore Thick-walled, usually pigmented, resting spore formed by fungi of the Zygomycotina.

Zygophyllaceae Family of xerophytic or halophytic, mostly woody, perennial shrubs, with some herbs and trees, in which the leaves are opposite, usually fleshy, leathery, or hairy, with stipules which often become spiny. The branches are sometimes joined at the nodes. The flowers are regular, bisexual, and are held in cymes, paired, or solitary. They have four or five overlapping sepals and the same number of petals, usually also overlapping, although in some species the petals are absent. The stamens are in whorls of five with up to three whorls. The ovary is superior, usually of five fused carpels, and often winged. There are usually five locules with numerous ovules. The stigmas are lobed and held in a short style. The fruit is a dehiscent capsule, or berry- or drupe-like, containing endospermic seeds. There are six subfamilies, divided mainly by the structure of their fruit. The family contains some valuable timber trees, e.g. of *Guaiacum* species (lignum vitae) which give a very durable timber. Other species produce edible fruit, and some are used medicinally. There are 25 genera, with 240 species, found in tropical and subtropical regions.

Zygophyllum (family Zygophyllaceae) Genus of low-lying, small, bushy shrubs found in deserts and arid regions. They have fleshy, opposite leaves, mostly bifoliate, or occasionally with several pairs of leaflets, and often with spiny stipules. The stems are fleshy. The flowers are solitary or paired, terminal, and yellow or white in colour, with a red or purple spot at the base of the petal. There are four or five overlapping sepals and the same number of petals, which are usually overlapping and clawed. There are twice the number of stamens, held in whorls. The ovary is superior, with four or five locules, and a simple style with a very small stigma. The fruit is a capsule, angled along the locule partitions, or winged. There are 100 species, found in tropical and subtropical regions of the Old World, and in Australia.

Zygoptera (damselflies; class Insecta, order Odonata) Cosmopolitan suborder of dragonflies, comprising insects with slender bodies, and two pairs of wings. Both hind- and forewings have a narrow base, and are held over the abdomen when the insect is at rest. Damselflies are generally weak fliers, frequenting bankside vegetation. The aquatic nymphs have three elongate, caudal gills of varying form, at the end of the abdomen. There are 18 families, containing about 3000 species.

zygote The fertilized ovum of an animal or plant formed from the fusion of male and female gametes, when, under normal circumstances, the diploid chromosome number is restored, in the stage before it undergoes division.

zygotene *See* meiosis; and prophase.

zymase Heat-labile, non-dialysable enzyme fraction derived from yeast cells, which catalyses alcoholic fermentation.

zymogen (pro-enzyme) The inactive precursor of an enzyme, subsequently activated by specific partial proteolysis.

zymogen granule One of the dense, membrane-bound bodies containing zymogen, derived from the Golgi body of cells. They occur in particularly large numbers in secretory cells such as the acinar cells of the pancreas.

zymogenous Applied to organisms whose presence in a given habitat is transient; the numbers of such organisms fluctuate greatly in response to the availability of particular nutrients, for example.

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From the Foreword by David Attenborough

'Here, for each of many thousands of scientific terms, are those few words of definition that will enable you, whether scientist, naturalist, or both, to understand the word and the sentence in which it is embedded. The entries have been assembled and defined by over fifty experts from a dozen different disciplines. I know of no other compilation that is so up-to-date and so comprehensive. Maybe, in some laboratory or library somewhere, there sits some scientific polymath who, alone and unaided, knows the meaning of each and every one of these words. I am not he. I am delighted — and relieved — to have at last a volume at my elbow that will illuminate my way through the fascinating literature of natural history, no matter where it may lead me.'

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